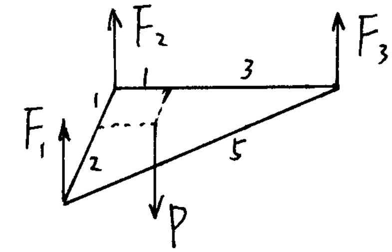
1. Solution:

From geometry, we can find that $a=1$, so load applied at $x=1$, $y=1$.



$$\sum F_z = 0 \Rightarrow F_1 + F_2 + F_3 = P \quad \text{---} (A)$$

$$\sum M_x = 0 \Rightarrow 4F_3 = P \Rightarrow F_3 = P/4$$

$$\sum M_y = 0 \Rightarrow 3F_1 = P \Rightarrow F_1 = P/3$$

$$\text{So } (A) \Rightarrow F_2 = P - P\left(\frac{1}{4} + \frac{1}{3}\right) = \frac{5}{12}P$$

$$\text{T.C.E.} \Rightarrow C = \sum_{i=1}^{3} \int_0^{F_i} \frac{F_i L}{AE}\, dF_i - P\Delta$$

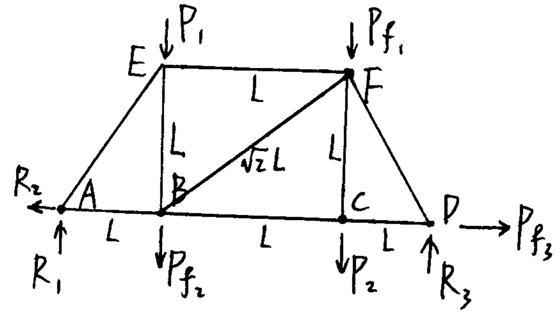
Stationary value $\frac{\partial C}{\partial P} = 0 \Rightarrow \sum_{i=1}^{3} \frac{F_i L}{AE} \frac{\partial F_i}{\partial P} = \Delta$

Member	F_i	$\partial F_i / \partial P$
1	$P/3$	$1/3$
2	$5P/12$	$5/12$
3	$P/4$	$1/4$

$$\text{So, } \Delta = \frac{PL}{AE}\left[\left(\frac{1}{3}\right)^2 + \left(\frac{5}{12}\right)^2 + \left(\frac{1}{4}\right)^2\right]$$

$$= \underline{\underline{0.3248 \text{ mm}}}$$

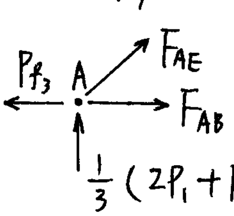
2. Apply frictitious loads at B, F, D in direction of Δ's.



$$\sum F_x = 0 \Rightarrow \underline{R_2 = P_{f_3}}$$

$$\sum M_A = 0 \Rightarrow L(P_{f_2} + 2P_2 - 3R_3 + P_1 + 2P_{f_1}) = 0 \Rightarrow \underline{R_3 = (P_1 + 2P_2 + 2P_{f_1} + P_{f_2})/3}$$

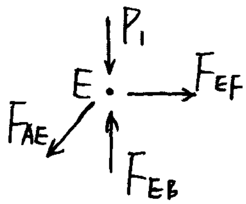
$$\sum F_y = 0 \Rightarrow R_1 = P_1 + P_{f_1} + P_{f_2} + P_2 - R_3 \Rightarrow \underline{R_1 = \frac{2}{3}P_1 + \frac{1}{3}P_2 + \frac{1}{3}P_{f_1} + \frac{2}{3}P_{f_2}}$$



$$\begin{cases} \sum F_x = 0 \Rightarrow \frac{\sqrt{2}}{2} F_{AE} + F_{AB} = P_{f_3} \\ \sum F_y = 0 \Rightarrow \frac{1}{3}(2P_1 + P_2 + P_{f_1} + 2P_{f_2}) + \frac{\sqrt{2}}{2} F_{AE} = 0 \end{cases}$$

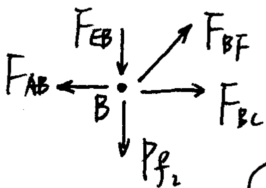
$$\therefore \quad \underline{F_{AE} = -\frac{\sqrt{2}}{3}(2P_1 + P_2 + P_{f_1} + 2P_{f_2})}$$

$$\underline{F_{AB} = P_{f_3} + \frac{1}{3}(2P_1 + P_2 + P_{f_1} + 2P_{f_2})}$$



(E) $\Sigma F_x = 0 \Rightarrow F_{EF} = \frac{\sqrt{2}}{2} F_{AE} \Rightarrow \underline{F_{EF} = -\frac{1}{3}(2P_1 + P_2 + P_{f_1} + 2P_{f_2})}$

$\Sigma F_y = 0 \Rightarrow F_{EB} = P_1 + \frac{\sqrt{2}}{2} F_{AE} \Rightarrow \underline{F_{EB} = \frac{1}{3}(P_1 - P_2 - P_{f_1} - 2P_{f_2})}$

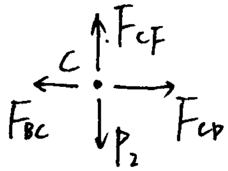


(B) $\Sigma F_x = 0 \Rightarrow \frac{\sqrt{2}}{2} F_{BF} + F_{BC} - F_{AB} = 0$

$\Rightarrow \underline{F_{BC}} = F_{AB} - \frac{\sqrt{2}}{2} F_{BF} = \underline{P_{f_3} + \frac{1}{3}(P_1 + 2P_2 + P_{f_2} + 2P_{f_1})}$

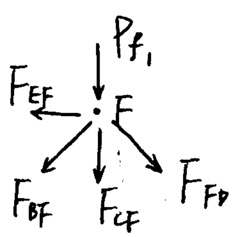
$\Sigma F_y = 0 \Rightarrow \frac{\sqrt{2}}{2} F_{BF} - F_{EB} - P_{f_2} = 0$

$\Rightarrow \underline{F_{BF}} = \sqrt{2}(F_{EB} + P_{f_2}) = \underline{\frac{\sqrt{2}}{3}(P_1 - P_2 - P_{f_1} + P_{f_2})}$



(C) $\Sigma F_x = 0 \Rightarrow \underline{F_{CD} = F_{BC} = P_{f_3} + \frac{1}{3}(P_1 + 2P_2 + P_{f_2} + 2P_{f_1})}$

$\Sigma F_y = 0 \Rightarrow \underline{F_{CF} = P_2}$



(F) $\Sigma F_x = 0 \Rightarrow \frac{\sqrt{2}}{2} F_{FD} - F_{EF} - \frac{\sqrt{2}}{2} F_{BF} = 0$

$\Rightarrow \underline{F_{FD}} = \sqrt{2} F_{EF} + F_{BF} = \underline{-\frac{\sqrt{2}}{3}(P_1 + 2P_2 + 2P_{f_1} + P_{f_2})}$

Member	F_i	$F_i/10^3$	$\partial F_i/\partial P_{f_1}$	$\partial F_i/\partial P_{f_2}$	$\partial F_i/\partial P_{f_3}$	L_i
AB	$P_{f_3} + \frac{1}{3}(2P_1 + P_2 + P_{f_1} + 2P_{f_2})$	60	$1/3$	$2/3$	1	L
AE	$-\frac{\sqrt{2}}{3}(2P_1 + P_2 + P_{f_1} + 2P_{f_2})$	$-60\sqrt{2}$	$-\sqrt{2}/3$	$-2\sqrt{2}/3$	0	$\sqrt{2}L$
EB	$\frac{1}{3}(P_1 - P_2 - P_{f_1} - 2P_{f_2})$	-20	$-1/3$	$-2/3$	0	L
EF	$-\frac{1}{3}(2P_1 + P_2 + P_{f_1} + 2P_{f_2})$	-60	$-1/3$	$-2/3$	0	L
BF	$\frac{\sqrt{2}}{3}(P_1 - P_2 - P_{f_1} + P_{f_2})$	$-20\sqrt{2}$	$-\sqrt{2}/3$	$\sqrt{2}/3$	0	$\sqrt{2}L$
BC	$P_{f_3} + \frac{1}{3}(P_1 + 2P_2 + 2P_{f_1} + P_{f_2})$	80	$2/3$	$1/3$	1	L
FC	P_2	100	0	0	0	L
CD	$P_{f_3} + \frac{1}{3}(P_1 + 2P_2 + P_{f_2} + 2P_{f_1})$	80	$2/3$	$1/3$	1	L
FD	$-\frac{\sqrt{2}}{3}(P_1 + P_{f_2} + 2P_{f_1} + P_{f_2})$	$-80\sqrt{2}$	$-2\sqrt{2}/3$	$-\sqrt{2}/3$	0	$\sqrt{2}L$

$$\therefore \Delta_1 = \sum_{i=1}^{9} \frac{F_i L_i}{A_i E_i} \frac{\partial F_i}{\partial P_{f_1}}, \quad \Delta_2 = \sum_{i=1}^{9} \frac{F_i L_i}{A_i E_i} \frac{\partial F_i}{\partial P_{f_2}}, \quad \Delta_3 = \sum_{i=1}^{9} \frac{F_i L_i}{A_i E_i} \frac{\partial F_i}{\partial P_{f_3}}$$

So, $\Delta_1 = \dfrac{L}{AE}\left(20 + 40\sqrt{2} + \dfrac{20}{3} + 20 + \dfrac{40\sqrt{2}}{3} + \dfrac{160}{3} + \dfrac{160}{2} + \dfrac{320}{3}\right) = 335.413\,\dfrac{L}{AE}$

$\Delta_2 = \dfrac{L}{AE}\left(40 + 80\sqrt{2} + \dfrac{40}{3} + 40 - \dfrac{40}{3}\sqrt{2} + \dfrac{80}{3} + \dfrac{80}{3} + \dfrac{160}{3}\sqrt{2}\right) = 316.333\,\dfrac{L}{AE}$

$\Delta_3 = \dfrac{L}{AE}\left(60 + 80 + 80\right) = 220\,\dfrac{L}{AE}$

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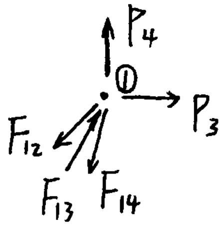
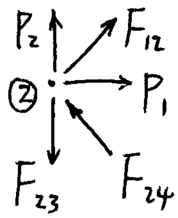
3. Solution: Must find internal member forces.



$$\begin{cases} \Sigma F_x = 0 : & P_3 - \frac{5}{13}F_{14} + \frac{9}{15}F_{13} - \frac{1}{\sqrt{2}}F_{12} = 0 \\ \Sigma F_y = 0 : & P_4 - \frac{12}{13}F_{14} + \frac{12}{15}F_{13} - \frac{1}{\sqrt{2}}F_{12} = 0 \end{cases}$$

Subtracting $\Rightarrow$ $\underline{F_{13} = \frac{35}{13}F_{14} + 5P_3 - 5P_4}$

Therefore: $\underline{F_{12} = \sqrt{2}\left(\frac{16}{13}F_{14} + 4P_3 - 3P_4\right)}$



$\Sigma F_x = 0$: $P_1 + \frac{1}{\sqrt{2}}F_{12} - \frac{4}{5}F_{24} = 0$

$\Rightarrow$ $\underline{F_{24} = \frac{20}{13}F_{14} + \frac{5}{4}P_1 + 5P_3 - \frac{15}{4}P_4}$

$\Sigma F_y = 0$: $P_2 + \frac{1}{\sqrt{2}}F_{12} + \frac{3}{5}F_{24} - F_{23} = 0$

$\Rightarrow$ $\underline{F_{23} = \frac{28}{13}F_{14} + \frac{3}{4}P_1 + P_2 + 7P_3 - \frac{21}{4}P_4}$

Member	F_i	$\partial F_i/\partial F_{14}$	L_i/A_i
14	F_{14}	1	$13a/A$
13	$\frac{35}{13}F_{14} + 5P_3 - 5P_4$	$35/13$	$15a/A$
12	$\sqrt{2}\left[\frac{16}{13}F_{14} + 4P_3 - 3P_4\right]$	$\sqrt{2}\,(16)/13$	$9a/A$
24	$\frac{20}{13}F_{14} + \frac{5}{4}P_1 + 5P_3 - \frac{15}{4}P_4$	$20/13$	$5a/A$
23	$\frac{28}{13}F_{14} + \frac{3}{4}P_1 + P_2 + 7P_3 - \frac{21}{4}P_4$	$28/13$	$3a/A$

T.C.E. $\Rightarrow$ $C = \sum_{i=1}^{5}\int^{F_i}\frac{F_iL_i}{A_iE_i}\,dF_i - P_1\Delta_1 - P_2\Delta_2 - P_3\Delta_3 - P_4\Delta_4$

$\frac{\partial C}{\partial F_{14}} = 0$ $\Rightarrow$ $\frac{1}{E}\sum_{i=1}^{5}\frac{F_iL_i}{A_i}\frac{\partial F_i}{\partial F_{14}} = 0$ from which it can be found that

$$\frac{a}{13AE}\left[\frac{27504}{13}F_{14} + 188P_1 + 4865P_3 + 84P_2 - 4305P_4\right] = 0$$

$$\Rightarrow\ 188P_1 + 4865P_3 + 84P_2 - 4305P_4 = -\frac{27504}{13}(0.7)A$$

To find temperature change: $-\Delta_T = -L_{14}\alpha\Delta T$

$$C = \sum_{i=1}^{5}\int^{F_i}\frac{F_iL_i}{A_iE_i}\,dF_i - P_1\Delta_1 - P_2\Delta_2 - P_3\Delta_3 - P_4\Delta_4 + F_{14}\Delta_T$$

$$\partial C/\partial F_{14} = 0 \ \Rightarrow\ -\Delta_T \equiv -L_{14}\alpha\Delta T = \sum_{i=1}^{5}\frac{F_iL_i}{A_iE_i}\frac{\partial F_i}{\partial F_{14}}$$

$$\Delta T = \frac{27504(0.7)Aa}{(13^2)AEL_{14}\alpha} = \frac{27504(0.7)(10^6)}{(13^2)(70\cdot10^3)(9\sqrt{2})(24)} = \underline{5.33\ ^\circ C}$$