

C-D

$$U_B = \int_0^L \frac{M^2}{2EI} dx = \frac{1}{2EI} \int_0^{4'} (-Py')^2 dy'$$

$$= \frac{P^2}{2EI} \int_0^{4'} y'^2 dy' = \underline{\underline{\frac{P^2 y^3}{6EI}}}$$

Q-C

$$U_B = \int_0^{-20'} \frac{M^2}{2EI} dx' = \frac{16ft^2 P^2}{2EI} \int_0^{-20'} dx' = \frac{320ft^3 P^2}{2EI}$$

$$= \frac{160ft^3 P^2}{EI}$$

$$U_N = \int_0^{-20'} \frac{P^2}{2AE} dx' = -\frac{P^2 \cdot 20ft}{2AE} = -\underline{\underline{\frac{10ft \cdot P^2}{4E}}}$$

a-b

$$U_B = \int_0^L \frac{M^2}{2EI} dx = \frac{1}{2EI} \int_0^L (-4ft \cdot P + Fx')^2 dx'$$

$$= \frac{1}{2EI} \int_0^L (F^2 x'^2 - 8ft \cdot P \cdot F \cdot x' + 16ft^2 \cdot P^2) dx'$$

$$= \frac{1}{2EI} \left[\frac{F^2 x'^3}{3} - \frac{8ft \cdot P \cdot F x'^2}{2} + 16ft^2 \cdot P^2 x' \right]_0^{10'}$$

$$= \frac{1}{2EI} [333.3ft^3 \cdot F^2 - 400ft^3 \cdot P \cdot F + 160ft^3 P^2]$$

$$U_N = \int_0^{10'} \frac{P^2}{2AE} = \frac{10ft \cdot P^2}{2AE} = \frac{5ft \cdot P^2}{AE}$$

$$U = \frac{P^2 y^3}{6EI} + \frac{160ft^3 P^2}{EI} + \frac{1}{2EI} [333.3ft^3 \cdot F^2 - 400ft^3 \cdot P \cdot F + 160ft^3 P^2] + \frac{5ft \cdot P^2}{AE}$$

$$\delta_F = 0 = \frac{\partial U}{\partial F} = \frac{1}{2EI} [666.6ft^3 F - 400ft^3 \cdot P]$$

$$F = \frac{400ft^3}{666.6ft^3} P = \boxed{600lb}$$

