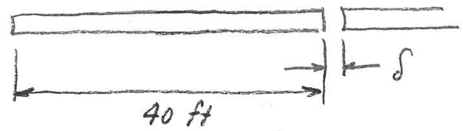
(4-75)



δ so rails just touch when $\Delta T = 90°F - (-20°F) = 110°F$

$$\delta = \alpha \Delta T L = \left(6.6 \times 10^{-6} \frac{1}{°F}\right)(110°F)\left(40 \text{ ft}\left(\frac{12 \text{ in}}{\text{ft}}\right)\right) = \boxed{0.348 \text{ in.}}$$

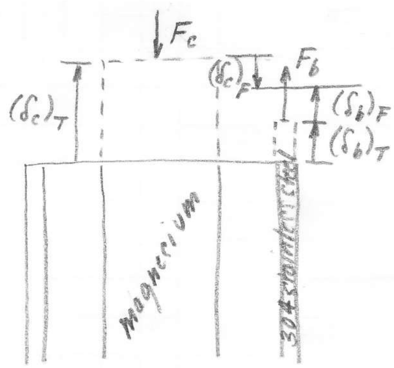
force in rail after gap closed ; $\Delta T = 110°F - 90°F = 20°F$

$$\delta_T = \delta_F$$

$$\left(6.6 \times 10^{-6} \frac{1}{°F}\right)(20°F)\cancel{\left(40 \text{ ft}\left(\frac{12 \text{ in}}{\text{ft}}\right) + 0.348 \text{ in}\right)} = \frac{F \cancel{\left(40 \text{ ft}\left(\frac{12 \text{ in}}{\text{ft}}\right) + 0.348 \text{ in}\right)}}{(5.10 \text{ in}^2)\left(29{,}000 \frac{\text{kip}}{\text{in}^2}\right)}$$

$$\boxed{F = 19.5 \text{ kip}}$$

(4-81)



equilibrium: $\Sigma F_y = 0$, $F_b = F_c$ — force in steel, both bolts

compatibility:

$$(\delta_c)_T - (\delta_c)_F = (\delta_b)_T + (\delta_b)_F$$

$$(\delta_c)_F + (\delta_b)_F = (\delta_c)_T - (\delta_b)_T$$

load displacement: subst $F_b = F_c$

	units	cylinder	bolt
α	$\frac{1}{°C}$	26×10^{-6}	17×10^{-6}
E	$\frac{kN}{m^2}$	44.7×10^6	193×10^6
L	m	0.100	0.150
r	m	0.025	0.005

$$\frac{F_c(0.100 \text{ m})}{\pi(0.025 \text{ m})^2\left(44.7 \times 10^6 \frac{kN}{m^2}\right)} + \frac{F_c(0.150 \text{ m})}{\underbrace{2}_{\text{two bolts}}\pi(0.005 \text{ m})^2\left(193 \times 10^6 \frac{kN}{m^2}\right)} =$$

$$\left(26 \times 10^{-6} \frac{1}{°C}\right)(110°C)(0.100 \text{ m}) - \left(17 \times 10^{-6} \frac{1}{°C}\right)(110°C)(0.150 \text{ m})$$

$$1.1394 \times 10^{-6} \frac{m}{kN} F_c + 4.9478 \times 10^{-6} \frac{m}{kN} F_c =$$

$$6.0872 \times 10^{-6} \frac{m}{kN} F_c = 5.50 \times 10^{-6} \text{ m}$$

$$F_c = 0.9035 \text{ kN or } \boxed{904 \text{ N}}$$