

ms note: OD  
corrected to 43.5  
for final calcs

Location: Columbus, OH

**Input:**

Working Pressure:  $P_w := 150$  psi

Pipe ID := 36 inch

Pipe OD := 48 inch

Pipe Weight:  $W_p := 404$  lb/ft

Earth Cover:  $H_e := 6$  ft

Joint Diameter:  $JD := 41$  inch

Cylinder OD:  $d_{yo} := 40.5$  inch

Soil Density:  $\rho_s := 110$  lb/ft<sup>3</sup>

**Calculation:**

ms note: equation is similar but not equal to M-9 Equation 9-14 (PDF pg 157)

$$\text{Joint Area: } A_j := \frac{JD^2 \cdot \pi}{4}$$

Elbow Angle:  $\theta := 45$

Required restrained length:

$$L_w := \frac{2P_w \cdot A_j \cdot \sin\left(\frac{\theta \cdot \text{deg}}{2}\right)}{\left[\left(\frac{OD}{12} \cdot H_e \cdot \rho_s\right) + W_p + \left(\frac{ID}{12}\right)^2 \cdot \frac{\pi}{4} \cdot 62.4\right] \cdot \cos\left(\frac{\theta \cdot \text{deg}}{2}\right)}$$

$L_w = 47$  ft

Wf=weight of the fluid=Ww

Elbow Angle:  $\theta_w := 22.5$

Required restrained length:

$$L_{w_w} := \frac{2P_w \cdot A_j \cdot \sin\left(\frac{\theta \cdot \text{deg}}{2}\right)}{\left[\left(\frac{OD}{12} \cdot H_e \cdot \rho_s\right) + W_p + \left(\frac{ID}{12}\right)^2 \cdot \frac{\pi}{4} \cdot 62.4\right] \cdot \cos\left(\frac{\theta \cdot \text{deg}}{2}\right)}$$

$L_w = 23$  ft

We=weight of the earth cover

Elbow Angle:  $\theta_w := 11.25$

Required restrained length:

$$L_{w_w} := \frac{2P_w \cdot A_j \cdot \sin\left(\frac{\theta \cdot \text{deg}}{2}\right)}{\left[\left(\frac{OD}{12} \cdot H_e \cdot \rho_s\right) + W_p + \left(\frac{ID}{12}\right)^2 \cdot \frac{\pi}{4} \cdot 62.4\right] \cdot \cos\left(\frac{\theta \cdot \text{deg}}{2}\right)}$$

$L_w = 11$  ft