Pipe Span Calculation (36" API-5L Gr. B WT=0.312")

This calculate the pipe span with given deflection based on the B31.3 allowable bend stress.The formula from *Machinery's Handbook 29th Edition, page 269 (Table 1).*

$\rho cs := 7.85\frac{gm}{mL} = 490.059\cdot\frac{lb}{ft^3}$ $\rho w := 1\frac{gm}{mL} = 62.428\cdot\frac{lb}{ft^3}$ Density of steel and water

$Do := 36in$ $twall := 0.312in$ Pipe outside diameter/wall

$\Delta := 1.85in$ Maximum pipe deflection

$Di := Do - 2\cdot twall = 35.376\cdot in$ $Ro := Do \div 2$ $Ri := Di \div 2$ Pipe inside diameter/radius

$I := \pi\cdot\left(Ro^4 - Ri^4\right) \div 4 = 5569.5\cdot in^4$ moment of inertia about bending axis

$Z := \pi\cdot\left(Ro^4 - Ri^4\right) \div (4\cdot Ro) = 309.4\cdot in^3$ Section Modulus

$E := 30000000psi$ Elasticity modulus for CS

$Sh := 20000psi$ Allowable stress (B31.3 Appendix A), for Gr B. @~100F

$Wp := \pi\left(Ro^2 - Ri^2\right)\cdot\rho cs = 119\cdot\frac{lb}{ft}$ $Ww := \pi\cdot Ri^2\cdot\rho w = 426.1\cdot\frac{lb}{ft}$ Weight per foot (pipe and water)

$Wt := (Wp + Ww)\cdot g = 545.2\cdot\frac{lbf}{ft}$ Uniform load per ft (pipe plus water)

For simple Supported beam (free both ends)

$Ld := \left(\frac{\Delta\cdot 384\cdot E\cdot I}{5\cdot Wt}\right)^{0.25} = 70.9\cdot ft$ Span @ given maximum deflection

$Ls := \left(\frac{8\cdot Sh\cdot Z}{Wt}\right)^{0.5} = 87\cdot ft$ Span @ maximum stress (B31.3 Appendix A)(outer fiber)

For both ends fixed

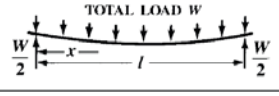
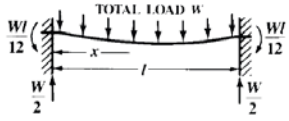
$Ldf := \left(\frac{\Delta\cdot 384\cdot E\cdot I}{1\cdot Wt}\right)^{0.25} = 105.9\cdot ft$ Span if both ends fixed @maximum deflection

$Lsf := \left(\frac{12\cdot Sh\cdot Z}{Wt}\right)^{0.5} = 106.5\cdot ft$ Span @ maximum stress (B31.3 Appendix A)(outer fiber)

$\min(Ldf, Lsf) = 105.9\cdot ft$ **For on the line with more than three support**

For one end free and one end fixed

$Lc := 0.803\cdot Ldf = 85\cdot ft$

	$s = -\frac{W}{2Zl}x(l-x)$	Stress at center, $\frac{Wl}{8Z}$ If cross-section is constant, this is the maximum stress.	$y = \frac{Wx(l-x)}{24EIl}[l^2 + x(l-x)]$	Maximum deflection, at center, $\frac{5}{384}\frac{Wl^3}{EI}$
	$s = \frac{Wl}{2Z}\left\{\frac{1}{6} - \frac{x}{l} + \left(\frac{x}{l}\right)^2\right\}$	Maximum stress, at ends, $\frac{Wl}{12Z}$ Stress is zero at $x = 0.7887l$ and at $x = 0.2113l$ Greatest negative stress, at center, $-\frac{Wl}{24Z}$	$y = \frac{Wx^2}{24EIl}(l-x)^2$	Maximum deflection, at center, $\frac{Wl^3}{384EI}$

5.2.5 Span Calculation Function of Sag

When the sag between supports is considered as the limiting factor, the formula used is:

$L = [\Delta \times E \times I/(K_{sg} \times w_t)]^{0.25}$ [feet]

Where the total uniform weight (w_t) is:
$w_t = w_p + w_c + w_i + w_{ice}$ [pounds/feet]

The values of the coefficient k_{sg}, are:

Pipes with Both Ends Fixed	Pipe Simply Supported	Combine Span
4.5	22.5	9.34

5.2.6 Span Calculation Function of Allowable Stress

When the allowable stress is considered as the limiting factor, the formula used is:

$L = (S_b \times Z/(k_{st} \times w_t \times i))^{0.5}$ [feet]

Where the values of the coefficient k_{St}, are:

Pipes with Both Ends Fixed	Pipe Simply Supported	Combine Span
1.0	1.5	1.5