Boardwalk and Trail Bridge Span Calculations

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1 Provenence

This document contains a copy of the equations in

ASD/LRFD Structural Wood Design Solved Example Problems, 2005 Edition, Problem 6, Span of a Floor Joist

This is because this document is a bit expensive and not available on the web.

Southern Pine Reference Design Values are obtained from the Southern Forest Products Association:

www.southernpine.com/wp-content/uploads/2023/09/TABLE01_L1.pdf

Acton snow load is obtained from the MA government:

https://www.mass.gov/doc/16table1604pdf/download

2 Reference Design Values

For #1 Standard Southern Pine 2”-4” dimensional width.

F_b = (bending, C_D and $C_M[F_b]$ apply)

stringer dimensional height	F_b	$C_M[F_b]$
2”-4”	1,500 psi	0.85
5”-6”	1,350 psi	0.85
8”	1,250 psi	0.85
10”	1,050 psi	1.0
12”	1,000 psi	1.0

F_v = 175 psi (shear parallel to grain, C_D and $C_M[F_v]$ apply)

E = 1,600,000 psi (modulus of elasticity, $C_M[E]$ applies)

$F_{c\perp}$ = 565 psi (compression perpendicular to grain, $C_M[F_{c\perp}]$ applies)

$C_M[F_b]$ (wet service factor) = 0.85 when $F_b >$ 1,150 psi, = 1.0 when $F_b \leq$ 1,150 psi

$C_M[F_v]$ (wet service factor) = 0.97

$C_M[E]$ (wet service factor) = 0.9

$C_M[F_{c\perp}]$ (wet service factor) = 0.67

C_D (duration factor) = 1.6 (ten minutes); = 1.25 (seven days); = 0.9 (permanent - dead load)

C_t, C_L, C_F, C_{fu}, C_i, C_r, C_b = 1.0

deflection limit = span/240 (from MA construction code)

design bearing length = 1.5 in (from boardwalk construction)

Acton snow load = 55 psf (from MA government table)

3 Equations

In the following:

w = stringer actual width in inches
h = stringer actual height in inches
$span$ = stringer span in feet
W = weight on stringer in pounds force per linear foot (lbf/ft)

When necessary $span$ in inches is computed using

$$span \text{ in inches} = span \text{ in feet} \times \frac{12 \text{ inches}}{1 \text{ foot}}$$

3.1 Momentum Capacity (Bending)

$$F'_b = C_D \cdot C_M[F_b] \cdot F_b$$

$$S_x = \frac{w \cdot h^2}{6}$$

$M' = S_x \cdot F'_b$ (allowable moment)

$$M_{load} = W \cdot \frac{span^2}{8}$$

$$M_{load} \leq M'$$

3.2 Shear

$$V_{load} = W \cdot \frac{span}{2}$$

$$F'_v = C_D \cdot C_M[F_v] \cdot F_v$$

$$f_v = 3 \cdot \frac{V_{load}}{2 \cdot w \cdot h}$$

$$f_v \leq F'_v$$

3.3 Deflection

$E' = C_M[E] \cdot E$

$W_{defl} = 1.5 \cdot W_{\text{dead load}} + W_{\text{live load}}$

$$\Delta = \frac{5 \cdot W_{defl} \cdot span^4}{384 \cdot E' \cdot \frac{w \cdot h^3}{12}} \qquad \text{(deflection)}$$

$Delta \leq \text{deflection limit} = \dfrac{span}{240}$

3.4 Bearing Length

$P_{load} = W \cdot \dfrac{span}{2}$

$F'_{c\perp} = C_M[F_{c\perp}] \cdot F_{c\perp}$

$Area_{bearing} = \dfrac{P_{load}}{F'_{c\perp}}$

$Length_{bearing} = \dfrac{Area_{bearing}}{w}$

design bearing length $\geq Length_{bearing}$