

Wood Joist Analysis

Simple-span wood joist under uniform gravity load, analyzed per NDS 2018 ASD. Pint parses `input.yaml`, `calc.py` computes the member capacities and checks. Typst determines the gravity-load demands below; the checked Python inputs are reconciled to those values by the test suite.

Loads Determination

$L = 9 \text{ ft}$	Simple span
$B = 13 \text{ ft}$	Tributary spacing, on-center
$D = 25 \text{ psf}$	Dead load
$L_L = 50 \text{ psf}$	Live load
$w = (D + L_L)B = 975 \text{ plf}$	Total uniform line load, Typst-derived
$w_{\text{checked}} = 975 \text{ plf}$	Total uniform line load, checked input
$w_L = L_L B = 650 \text{ plf}$	Live uniform line load, Typst-derived
$w_{L,\text{checked}} = 650 \text{ plf}$	Live uniform line load, checked input
$M = w \frac{L^2}{8} = 9871.88 \text{ ft}\cdot\text{lbf}$	Maximum moment, Typst-derived
$M_{\text{checked}} = 9871.88 \text{ ft}\cdot\text{lbf}$	Maximum moment, checked input
$V = w \frac{L}{2} = 4387.5 \text{ lbf}$	Support shear, Typst-derived
$V_{\text{checked}} = 4387.5 \text{ lbf}$	Support shear, checked input
$R = V = 4387.5 \text{ lbf}$	Support reaction, Typst-derived
$R_{\text{checked}} = 4387.5 \text{ lbf}$	Support reaction, checked input

Section Properties

$b = 3.5 \text{ in}, d = 9.5 \text{ in}$	Joist width and depth
$A = bd = 33.25 \text{ in}^2$	Section area
$I_x = b \frac{d^3}{12} = 250.1 \text{ in}^4$	Moment of inertia
$S_x = b \frac{d^2}{6} = 52.6 \text{ in}^3$	Elastic section modulus

Material And Adjustment Factors

Species/grade = SP No. 2	NDS Supplement reference values
$F_b = 2400 \text{ psi}, F_v = 300 \text{ psi}$	Reference bending and shear
$F_{c\perp} = 565 \text{ psi}$	Reference compression perpendicular to grain
$E = 1700000 \text{ psi}, E'_{\min} = 510000 \text{ psi}$	Moduli of elasticity
$C_D = 1, C_M = 1, C_t = 1, C_F = 1$	Load duration, wet service, temperature, size
$C_r = 1, C_{fu} = 1, C_i = 1$	Repetitive member, flat use, incising

Flexure

$$l_e = 1 \text{ in}$$

Unbraced length of compression edge

$$R_B = \sqrt{l_e \frac{d}{b^2}} = 0.881$$

Slenderness ratio, NDS 3.3.3

$$F_b^* = F_b C_D C_M C_t C_F C_i C_r = 2400 \text{ psi}$$

Adjusted reference bending

$$F_{bE} = 1.20 \frac{E'_{min}}{R_B^2} = 789157.9 \text{ psi}$$

Critical buckling stress

$$C_L = \frac{1 + \frac{F_{bE}}{F_b^*}}{1.9} - \sqrt{\dots} = 0.9998$$

Beam stability factor, NDS 3.3.3

$$F'_b = F_b^* C_L C_{fu} = 2399.6 \text{ psi}$$

Adjusted bending

$$f_b = \frac{M}{S_x} = 2250.2 \text{ psi}$$

Acting bending stress

$$M_a = S_x F'_b = 10527.6 \text{ ft-lbf}$$

Allowable moment

Flexure

OK

$$f_b: 2250.18 \text{ psi} \quad F'_b: 2399.63 \text{ psi}$$

D/C: 0.94

Shear

$$F'_v = F_v C_D C_M C_t C_{vr} = 300 \text{ psi}$$

Adjusted shear

$$f_v = 3 \frac{V}{2A} = 197.932 \text{ psi}$$

Acting shear stress

Shear

OK

$$f_v: 197.93 \text{ psi} \quad F'_v: 300 \text{ psi}$$

D/C: 0.66

Bearing

$$l_b = 2.5 \text{ in}$$

Bearing length

$$l_{end} = 3 \text{ in}$$

Distance from member end to near edge of bearing, $\geq 3 \text{ in}$

$$C_b = \frac{l_b + 0.375}{l_b} = 1.15$$

Bearing area factor, NDS 3.10.4

$$F'_{c\perp} = F_{c\perp} C_M C_t C_i C_b = 649.75 \text{ psi}$$

Adjusted bearing

$$A_b = l_b b = 8.75 \text{ in}^2$$

Bearing area

$$f_{c\perp} = \frac{R}{A_b} = 501.43 \text{ psi}$$

Acting bearing stress

Bearing

OK

$$f_{c\perp}: 501.43 \text{ psi} \quad F'_{c\perp}: 649.75 \text{ psi}$$

D/C: 0.77

Deflection

$$\Delta_{\text{total}} = 5w \frac{L^4}{384EI_x} = 0.339 \text{ in}$$

Total-load deflection

$$\Delta_{\text{live}} = 5w_L \frac{L^4}{384EI_x} = 0.226 \text{ in}$$

Live-load deflection

$$\frac{L}{240} = 0.45 \text{ in}$$

Total-load limit

$$\frac{L}{360} = 0.3 \text{ in}$$

Live-load limit

Deflection (total)

OK

$$\Delta_{\text{total}}: 0.34 \text{ in} \quad \frac{L}{240}: 0.45 \text{ in}$$

D/C: 0.75

Deflection (live)

OK

$$\Delta_{\text{live}}: 0.23 \text{ in} \quad \frac{L}{360}: 0.3 \text{ in}$$

D/C: 0.75