

Wood Stud Column — Axial Capacity

Concentrically loaded 2x4 wood stud (SP / Southern Pine No. 2) analyzed for axial compression parallel to grain per NDS 2018 ASD. Pint parses input.yaml; calc.py computes the column stability factor C_p (NDS 3.7.1.5, Eq. 3.7-1) and the adjusted compression capacity. The governing limit state is compression with buckling about the weak axis.

Geometry And Axial Load

$$P = 400 \text{ lbf}$$

Axial load, compression (ASD)

$$L = 6 \text{ ft} = 72 \text{ in}$$

Total stud length

$$b = 1.5 \text{ in}, d = 3.5 \text{ in}$$

Actual dimensions of a nominal 2x4

$$A = bd = 5.25 \text{ in}^2$$

Cross-sectional area

$$K_e = 1$$

Effective-length factor, pinned-pinned (NDS 3.7.1.2)

$$L_e = K_e L = 72 \text{ in}$$

Effective length

$$d_{\min} = \min(b, d) = 1.5 \text{ in}$$

Least dimension; weak-axis buckling governs

$$\frac{L_e}{d_{\min}} = 48 \leq 50$$

Slenderness ratio, weak axis; cap $\frac{L_e}{d} \leq 50$ (NDS 3.7.1.4)

Material And Adjustment Factors

$$\text{Species/grade} = \text{SP (Southern Pine) No. 2}$$

NDS Supplement reference values

$$F_c = 1450 \text{ psi}$$

Reference compression parallel to grain

$$E = 1400000 \text{ psi}, E'_{\min} = 510000 \text{ psi}$$

Moduli of elasticity

$$C_D = 1, C_M = 1, C_t = 1, C_F = 1.15, C_i = 1$$

Load duration ($C_D = 1.0$ normal/occupancy, NDS 2.3.2), wet service, temperature, size ($C_F = 1.15$ for 2x4 compression, NDS 4.3.6), incising (NDS Table 4.3.1)

Column Stability Factor (NDS 3.7.1.4)

$$F_c^* = F_c C_D C_M C_t C_F C_i = 1667.5 \text{ psi}$$

Adjusted reference compression, NDS 3.7.1.5

$$E'_{\min} = E_{\min} C_M C_t C_i = 510000 \text{ psi}$$

Adjusted 5th-percentile modulus

$$F_{cE} = 0.822 \frac{E'_{\min}}{\left(\frac{L_e}{d_{\min}}\right)^2} = 181.95 \text{ psi}$$

Critical buckling stress, NDS Eq. 3.7-2 (coefficient 0.822)

$$0.822 \text{ (Euler coeff., NDS Eq. 3.7-2), } c = 0.8$$

Sawn-lumber column coefficient, NDS Eq. 3.7-1

$$C_p = \frac{1 + \frac{F_{cE}}{F_c^*}}{2c} - \sqrt{\dots} = 0.1066$$

Column stability factor, NDS Eq. 3.7-1 (3.7.1.5); weak axis governs

Adjusted Compression Capacity

$$F'_c = F_c^* C_p = 177.71 \text{ psi}$$

Adjusted compression design value, NDS 3.7.1.5

$$f_c = \frac{P}{A} = 76.19 \text{ psi}$$

Acting compression stress

$$P_a = F'_c A = 933 \text{ lbf}$$

Allowable axial load

Axial Compression

OK

P : 400 lbf P_u : 932.99 lbf

D/C: 0.43