Architecture 324: Structures II

Wood Joist Design

Problem 2: Floor Joist Design — Eastern Softwoods

Task: Design a 2x dimensioned lumber floor joist to carry the given dead + live floor load (neglect joist selfweight). Assume conditions of 4.4.1 ($C_L = 1.0$), CD, Ct, CL Cfu and Ci each =1.0. Find the short term deflection under live load only. Check against code limit L/360.

Given Data: Species: Eastern Softwoods — Grade: Select Structural — Span: 15 ft — Spacing: 19.2 in — DL: 9 PSF — LL: 30 PSF — M.C.: 15%

Q1–Q3: Tabulated F_b, F_v, and E

1. Refer to **Table 4A** in NDS Supplement.
2. Locate **Eastern Softwoods** (Select Structural).
3. *Note: Ensure you check the specific shear value for this species group.*

F_b =_____ psi, F_v =_____ psi, E =_____ psi

Q4 Total Applied Floor Load (PSF)

1. Add dead load and live load:
   Total Load = $DL + LL$ = _____ PSF

Q5 Load on Joist, w (PLF)

1. Convert the joist spacing to feet:
   Spacing S = Spacing (in)/12 = _____ ft
2. Calculate line load:
   w = Total Load (Q4) × S = _____ PLF

Q6 Actual Beam Bending Moment, M

$$M = \frac{w \cdot L^2}{8}$$

1. Extract span: L = _____ ft
2. Calculate Moment:
   M = _____ ft-lb

Q7 Actual Maximum Shear Force, V

$$V = \frac{w \cdot L}{2}$$

1. Calculate Shear:
   V = _____ lbs

Q8 Nominal Depth of Final Joist Used

1. conver M from ft-lb to in-lb = M x 12= _____ in-lb
2. Estimate F'b (CF is not yet known) _____ psi
3. $S_{xx} = M/F_b$= _____ in^3
4. refer to table 1B in NDS supllement. Select a trial size (e.g., 2×8, 2×10) and start with the smallest size that might pass stress checks.
5. Enter the **Nominal Depth** :
   Nominal Depth = _____ IN

Q9 Size Factor, C_F

Refer to NDS Supplement Table 4A (Adjustment Factors).

1. Based on the nominal depth chosen in Q8 and the grade (Select Structural).

C_F = _____

Q10 Repetitive Member Factor, C_r

1. Check joist spacing. If spacing $\leq 24''$ o.c. and there are ≥ 3 members, apply C_r.
2. For dimension lumber joists, standard $C_r = 1.15$.

C_r = _____

Q11–Q12 Wet Service Factors, C_M

1. Check moisture content (m.c.) from data.
2. If m.c. $\leq 19\%$, then $C_M = 1.0$.

C_{M_b} = _____, C_{M_v} = _____

Q13 Factored Allow. Bending Stress, F'_b

$$F'_b = F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_L \cdot C_F \cdot C_r$$

1. $C_D = 1.0$ (Occupancy Live Load), $C_t = 1.0$, $C_L = 1.0$.
2. Use F_b (Q1), C_F (Q9), and C_r (Q10).

F'_b = _____ psi

Q14 Factored Allow. Shear Stress, F'_v

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

1. Use F_v (Q2). Note: C_F and C_r do not apply to shear.

F'_v = _____ psi

Q15 Actual Bending Stress, $f_{b,actual}$

$$f_{b,actual} = \frac{M \times 12}{S}$$

1. Find Section Modulus S (in^3) for your chosen size (NDS Table 1B).
   S = _____ in^3
2. Calculate stress:

$f_{b,actual}$ = _____ psi

Q16 Actual Shear Stress, $f_{v,actual}$

$$f_{v,actual} = 1.5\frac{V}{A}$$

1. Find Area A (in^2) for your chosen size (NDS Table 1B).
   A = _____ in^2
2. Calculate stress:

$f_{v,actual}$ = _____ psi

Q17 Factored Modulus of Elasticity, E'

$$E' = E \cdot C_M \cdot C_t$$

1. Use E from Q3.

E' = _____ psi

Q18 Short Term Deflection (100% LL)

$$\Delta_{LL} = \frac{5 \cdot w_{LL} \cdot L^4}{384 \cdot E' \cdot I}$$

1. Calculate Live Load portion only:
   $w_{LL} = LL$ (psf) × S (ft) = _____ PLF
2. Convert w_{LL} to lb/in (divide by 12): _____ lb/in
3. Convert Span L to inches: _____ in
4. Find Moment of Inertia I (in^4) from NDS Table 1B: _____ in^4
5. Calculate Δ_{LL}:

Deflection Δ = _____ IN

Q19 Deflection Limit

$$\Delta_{limit} = L/360$$

1. Use Span L in inches.

Limit = _____ IN

Q20 Deflection Passing Check

1. Compare Q18 and Q19.
2. If $\Delta_{actual} \leq \Delta_{limit}$, enter "1". Else enter "0".

Pass/Fail (1/0): _____