Architecture 324: Structures II

Wood Column Analysis

Problem 3: Capacity Analysis — Eastern Softwoods

Given Data: Species: EASTERN SOFTWOODS **Grade:** Select Structural **Load:** Snow Load (C_D)
Section: 2×6 nominal **M.C.:** 15% ($C_t = C_i = 1.0$) **End Cond:** Pinned ($K_e = 1.0$)
Lengths: Strong Axis (L_1) = 14 FT Weak Axis (L_2) = 4.67 FT (1/3 point bracing)

Part 1: Reference Design Values

Q1 Tabulated Allowable Compressive Stress (F_c)

Formula: Lookup in NDS Table 4A

1. **Action:** Open **NDS Table 4A** (Reference Design Values).
2. **Locate:** Row for "Eastern Softwoods", Grade "Select Structural".
3. **Extract:** Value from F_c column (Parallel): ____________ PSI

Final F_c: ________________ PSI

Q2 Tabulated Min. Modulus of Elasticity (E_{min})

Formula: Lookup in NDS Table 4A

1. **Action:** In the same row as above, move to the E_{min} column.
2. **Extract:** Value for E_{min}: ____________ PSI

Final E_{min}: ________________ PSI

Part 2: Adjustment Factors

Q3 Load Duration Factor (C_D)

Formula: Lookup in NDS Table 2.3.2

1. **Identify:** Load Type is _________ months.
2. **Action:** Find factor in **Table 2.3.2**: ____________

Final C_D: ________________

Q4 Size Factor (C_F)

Formula: Lookup in NDS Table 4A Adjustment Factors

1. **Identify:** Nominal Width (d_1) = _________ inches.
2. **Action:** Refer to "Adjustment Factors" (Size Factor) in Table 4A.
3. **Extract:** Factor for F_c (Dimension Lumber): ____________

Final C_F: ________________

Q5 Factored Allow. Modulus of Elasticity (E'_{min})

$$E'_{min} = E_{min} \cdot C_M \cdot C_t \cdot C_T \cdot C_i$$

1. **Determine:** C_M (M.C. 15%): ______ C_t (Temp): ______
2. **Calculate:** E_{min} _________ $\times\ C_M$ _____ $\times\ C_t$ _____

Final E'_{min}: ________________ PSI

Part 3: Slenderness

Q6 Strong Axis ($x - x$) Slenderness (l_{e1}/d_1)

$$\text{Ratio} = \frac{L_1 \times 12}{d_1}$$

1. **Convert:** $L_1 = 14$ ft $\times\ 12 =$ ____________ inches.
2. **Identify:** Actual Depth d_1: ____________ inches.
3. **Divide:** Length _________ / Depth _________

Ratio: ________________

Q7 Weak Axis ($y - y$) Slenderness (l_{e2}/d_2)

$$\text{Ratio} = \frac{L_2 \times 12}{d_2}$$

1. **Convert:** $L_2 = 4.67$ ft $\times\ 12 =$ ____________ inches.
2. **Identify:** Actual Width d_2: ____________ inches.
3. **Divide:** Length _________ / Width _________

Ratio: ________________

Q8 Controlling Slenderness Ratio (l_e/d)

Formula: Max(Ratio x-x, Ratio y-y)

1. **Compare:** Look at Q6 and Q7.
2. **Select:** The larger (critical) value: ____________

Final l_e/d: ________________

Part 4: Column Stability

Q9 Critical Buckling Design Value (F_{cE})

$$F_{cE} = \frac{0.822 \cdot E'_{min}}{(l_e/d)^2}$$

1. **Step A:** Denominator $(l_e/d)^2 =$ (_______)^2 = _________
2. **Step B:** Numerator $0.822 \times E'_{min}$ (_________) = _________
3. **Calculate:** Step B / Step A

Final F_{cE}: ________________ PSI

Q10 Reference Compression Design Value (F_c^*)

$$F_c^* = F_c \cdot C_D \cdot C_F \cdot C_M \cdot C_t$$

1. **Instructions:** Multiply Tabulated stress by adjustment factors (except C_P).
2. **Input:** F_c ______ $\times C_D$ ______ $\times C_F$ ______

Final F_c^*: ________________ PSI

Q11 Constant for Sawn Lumber (c)

Formula: NDS Standard Constant

1. **Rule:** Standard interaction constant for visually graded lumber.

Value c: ________________

Q12 Column Stability Factor (C_P)

$$C_P = \frac{1 + (F_{cE}/F_c^*)}{2c} - \sqrt{\left[\frac{1 + (F_{cE}/F_c^*)}{2c}\right]^2 - \frac{F_{cE}/F_c^*}{c}}$$

1. **Ratio X:** $F_{cE}/F_c^* =$ _______ / _______ = _________
2. **Term A:** $(1 + X)/2c =$ ____________
3. **Term B:** $X/c =$ ____________
4. **Solve:** $C_P = A - \sqrt{A^2 - B} =$ _______ - _______

Final C_P: ________________

Part 5: Capacity

Q13 Factored Allow. Compressive Stress (F'_c)

$$F'_c = F_c^* \cdot C_P$$

1. **Formula:** F_c^* (Ref Value) $\times\ C_P$ (Stability Factor).
2. **Input:** ____________ $\times$ ____________

Final F'_c: ________________ PSI

Q14 Column Area (A)

$$A = b \times d$$

1. **Formula:** Actual Width (d_2) $\times$ Actual Depth (d_1).
2. **Input:** _________ $\times$ _________

Final Area: ________________ IN^2

Q15 Maximum Allowable Axial Load (P_{max})

$$P_{max} = F'_c \cdot A$$

1. **Formula:** Allowable Stress (F'_c) $\times$ Area (A).
2. **Input:** ____________ $\times$ ____________

Final P_{max}: ________________ LBS