Architecture 324: Structures II

LRFD Steel Beam Analysis

Problem 4: Beam Capacity Analysis — Dataset 1

Given Data: W-Section: W12×35 F_y**:** 50 KSI E**:** 29,000 KSI
Span A: 25 FT (beam span) **Span B:** 11 FT (tributary width) **Floor DL:** 18 PSF
Assumptions: Fully braced ($L_b < L_p$) Deflection Limit: $L/180$
LRFD Load Combo: $w_u = 1.2\,w_{DL} + 1.6\,w_{LL}$

Part 1: Section Properties (AISC Table 1-1)

Q1 Plastic Section Modulus (Z_x)

Lookup: AISC Table 1-1 → W12×35

1. **Action:** Open **AISC Table 1-1** (W-Shapes).
2. **Locate:** Row for W12×35.

Final Z_x**:** ________________ IN^3

Part 2: Flexural Capacity (Zone 1: $L_b < L_p$)

Q2 Nominal Bending Moment (M_n)

$$M_n = M_p = F_y \times Z_x$$

Final M_n**:** ________________ K-IN

Q3 Factored Bending Resistance ($\phi_b M_n$)

$$\phi_b M_n = 0.90 \times M_n$$

1. **Calculate:** 0.90× __________ K-IN

Final $\phi_b M_n$**:** ________________ K-IN

Q4 Factored Design Moment (M_u)

$$M_u = \phi_b M_n \quad \text{(set design at full capacity)}$$

1. **Convert to K-FT:** $M_u = \phi_b M_n \div 12$
   = __________ ÷ 12

Final M_u**:** ________________ K-FT

Part 3: Load Capacity

From $M_u = w_u L^2/8$, solve for w_u. Then: $w_u = 1.2\,w_{DL} + 1.6\,w_{LL}$, solve for w_{LL}.

Q5 Total Factored Design Load (w_u)

$$w_u = \frac{8\,M_u}{L^2}$$

1. **Numerator:** $8 \times M_u = 8\times$ ________ = __________
2. **Denominator:** $L^2 = (\text{Span A})^2 = ($______$)^2 =$ ________
3. **Divide:** ________ / ________

Final w_u**:** ________________ KLF

Q6 Total Unfactored Dead Load (w_{DL})

$$w_{DL} = w_{\text{beam}} + w_{\text{floor}}$$

1. **Beam Self-Wt:** W12×35 ⇒ ______ PLF
2. **Floor DL:** ______ PSF × Span B ______ FT = ________ PLF
3. **Sum & Convert:** (______ + ______) ÷ 1000

Final w_{DL}**:** ________________ KLF

Q7 Total Factored Dead Load ($w_{u,DL}$)

$$w_{u,DL} = 1.2 \times w_{DL}$$

Final $w_{u,DL}$**:** ________________ KLF

Q8 Factored Live Load ($w_{u,LL}$)

$$w_{u,LL} = w_u - w_{u,DL}$$

1. **Subtract:** ________ − ________

Final $w_{u,LL}$**:** ________________ KLF

Q9 Actual Beam Live Load Capacity (w_{LL})

$$w_{LL} = \frac{w_{u,LL}}{1.6}$$

1. **Unfactor:** __________ ÷ 1.6

Final w_{LL}**:** ________________ KLF

Q10 Floor Live Load Capacity (LL)

$$LL = \frac{w_{LL} \times 1000}{\text{Span B}}$$

1. **Convert & Distribute:** ________ KLF ×1000÷ ______ FT

Final LL**:** ________________ PSF

Part 4: Shear Check

Check shear zone via h/t_w, then verify $V_u < \phi_v V_n$.

Q11 Max. Factored Shear ($V_{u,\max}$)

$$V_{u,\max} = \frac{w_u \times L}{2}$$

1. **Calculate:** $w_u =$ ________ $\times L =$ ______ ÷ 2

Final $V_{u,\max}$**:** ________________ K

Q12 Web Area (A_w)

$$A_w = d \times t_w$$

1. **From Table 1-1:** $d =$ ________ IN $t_w =$ ________ IN
2. **Multiply:** ________ × ________

Final A_w**:** ________________ IN^2

Q13 Factored Shear Resistance ($\phi_v V_n$)

$$\phi_v V_n = \phi_v \times 0.6 \times F_y(steelyieldstress = 50K) \times A_w$$

(for zone 1, most beams are in this category)

1. $V_n = 0.6 \times F_y \times A_w$: 0.6× ______ × _______
2. **Factor:** $\phi_v V_n =$ _____ × ________

Final $\phi_v V_n$**:** ________________ K

Q14 Shear Adequacy Check

1. **Compare:** $V_{u,\max}$ ________ K vs. $\phi_v V_n$ ________ K
2. $V_u < \phi_v V_n$**?** __________ (1 = Yes, 0 = No)

Part 5: Deflection Check

Unfactored total D+L load; limit $L/180$.

Q15 Actual Deflection (Δ_{actual})

$$\Delta = \frac{5\,w\,L^4}{384\,E\,I_x} \quad \text{(all units: K, IN)}$$

1. **Total Unfactored:** $w = w_{DL} + w_{LL}$
   = ________ + ________ = ________ KLF
   Convert: ÷ 12 = ________ K/IN
2. **Span:** $L =$ ______ FT ×12 = ________ IN
3. **From Table 1-1:** $I_x =$ __________ IN^4
4. **Numerator:** $5 \times w \times L^4 =$ ________________
5. **Denominator:** $384 \times E \times I_x =$ ________________
6. **Divide:** Num / Den

Final Δ_{actual}**:** ________________ IN

Q16 Deflection Limit ($L/180$)

$$\Delta_{\text{limit}} = \frac{L \text{ (in)}}{180}$$

1. **Calculate:** __________ IN ÷ 180

Final Δ_{limit}**:** ________________ IN

Q17 Deflection Adequacy Check

1. **Compare:** Δ_{actual} ________ IN vs. Δ_{limit} ________ IN
2. $\Delta_{\text{actual}} < L/180$**?** __________ (1 = Yes, 0 = No)

Deflection OK? ________________