

# Architecture 324: Structures II

## LRFD Steel Beam Design

Problem: Design Beam B1 (Select Lightest W-Section)

**Given Data:** Span A (L): 29 FT    Span B (Trib. Width): 20 FT  
**Floor DL:** 19 PSF    **Floor LL:** 100 PSF     $F_y$ : 50 KSI  
**Assumptions:** Fully braced ( $L_b < L_p$ ), Neglect beam self-weight for preliminary selection.

### Part 1: Load Calculations (Neglecting Self-Weight)

#### Q1 Unfactored Floor Dead Load ( $w_{DL}$ )

$$w_{DL} = \text{Floor DL} \times \text{Trib. Width}$$

1. Calculate: \_\_\_\_\_ PSF  $\times$  \_\_\_\_\_ FT  
**Final  $w_{DL}$ :** \_\_\_\_\_ PLF

#### Q2 Unfactored Floor Live Load ( $w_{LL}$ )

$$w_{LL} = \text{Floor LL} \times \text{Trib. Width}$$

1. Calculate: \_\_\_\_\_ PSF  $\times$  \_\_\_\_\_ FT  
**Final  $w_{LL}$ :** \_\_\_\_\_ PLF

#### Q3 Total Factored Design Load ( $w_u$ )

$$w_u = 1.2(w_{DL}) + 1.6(w_{LL})$$

1. Dead:  $1.2 \times$  \_\_\_\_\_ = \_\_\_\_\_ PLF  
 2. Live:  $1.6 \times$  \_\_\_\_\_ = \_\_\_\_\_ PLF  
 3. Sum: \_\_\_\_\_ + \_\_\_\_\_ = \_\_\_\_\_ PLF  
 4. Convert to KLF: \_\_\_\_\_ PLF  $\div$  1000  
**Final  $w_u$ :** \_\_\_\_\_ KLF

#### Q4 Factored Design Moment ( $M_u$ )

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

1. Calculate: (\_\_\_\_\_ KLF  $\times$  (\_\_\_\_\_ FT)<sup>2</sup>)  $\div$  8  
**Final  $M_u$ :** \_\_\_\_\_ K-FT

### Part 2: Preliminary Section Selection

#### Q5 Nominal Bending Moment ( $M_n$ )

$$M_n = \frac{M_u}{\phi_b} \quad (\phi_b = 0.9)$$

1. Convert  $M_u$ : \_\_\_\_\_ K-FT  $\times$  12 = \_\_\_\_\_ K-IN  
 2. Divide: \_\_\_\_\_  $\div$  0.9  
**Final  $M_n$ :** \_\_\_\_\_ K-IN

#### Q6 Required Plastic Modulus ( $Z_x^*$ )

$$Z_x = \frac{M_n}{F_y}$$

1. Calculate: \_\_\_\_\_ K-IN  $\div$  50 KSI  
**Final  $Z_x^*$ :** \_\_\_\_\_ IN<sup>3</sup>

### Part 3: Select Lightest Section

#### Q7 Select W-Section

Lookup AISC Table (Z-Table). Find first section with  $Z_x \geq Z_x^*$ .

1. Min. Required  $Z_x$ : \_\_\_\_\_ IN<sup>3</sup>  
 2. Search Criteria: Look for bolded (lightest) sections.  
**Chosen Section:** W \_\_\_\_\_ x \_\_\_\_\_ (Depth: \_\_\_\_\_ IN)

#### Q8 Section Weight

**Weight:** \_\_\_\_\_ PLF

#### Q9 Section Properties ( $Z_x$ )

Actual  $Z_x$  of the chosen section from Table.    **Actual  $Z_x$ :** \_\_\_\_\_ IN<sup>3</sup>

### Part 4: Verification (Including Self-Weight)

#### Q10 Revised Dead Load ( $w_{DL,new}$ )

$$w_{DL,new} = w_{DL,floor} + w_{SW}$$

1. Sum: \_\_\_\_\_ PLF + \_\_\_\_\_ PLF  
**Final  $w_{DL}$ :** \_\_\_\_\_ PLF

#### Q11 Revised Factored Load ( $w_{u,new}$ )

$$w_u = 1.2(w_{DL,new}) + 1.6(w_{LL})$$

1. Sum (PLF):  $1.2(\text{_____}) + 1.6(\text{_____}) =$  \_\_\_\_\_ PLF  
 2. Convert to KLF: \_\_\_\_\_ PLF  $\div$  1000  
**Final  $w_u$ :** \_\_\_\_\_ KLF

#### Q12 Revised Moment ( $M_u$ in K-FT)

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

1. Calc: (\_\_\_\_\_  $\times$  \_\_\_\_\_<sup>2</sup>)  $\div$  8  
**Final  $M_u$ :** \_\_\_\_\_ K-FT

#### Q13 Revised Moment ( $M_u$ in K-IN)

$$M_u \text{ (K-IN)} = M_u \text{ (K-FT)} \times 12$$

**Final  $M_u$ :** \_\_\_\_\_ K-IN

#### Q14 Design Strength Check ( $\phi M_n$ )

$$\phi M_n = 0.9 \times F_y \times Z_{x,actual}$$

**Final  $\phi M_n$ :** \_\_\_\_\_ K-IN