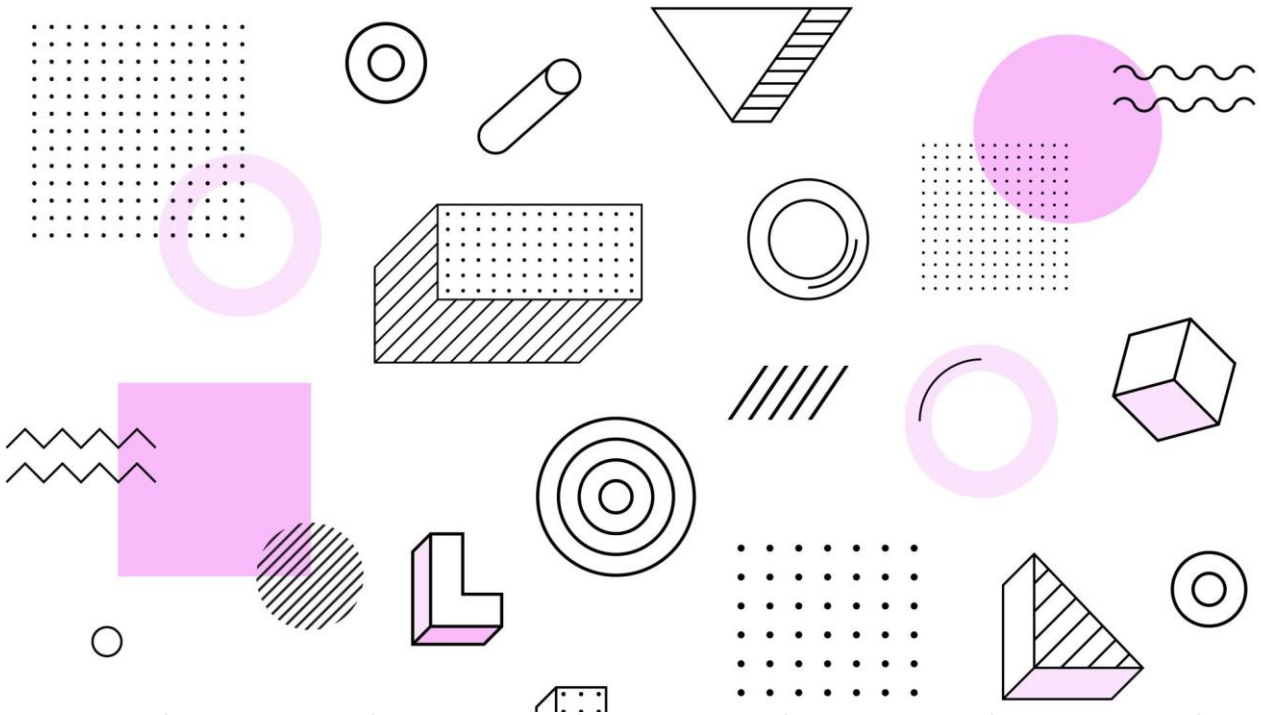
ARCH 324 STRUCTURE II

FACULTY: Prof. Peter Von Bulow

GSI: Faezeh Choobkar

Winter 2025

Recitation



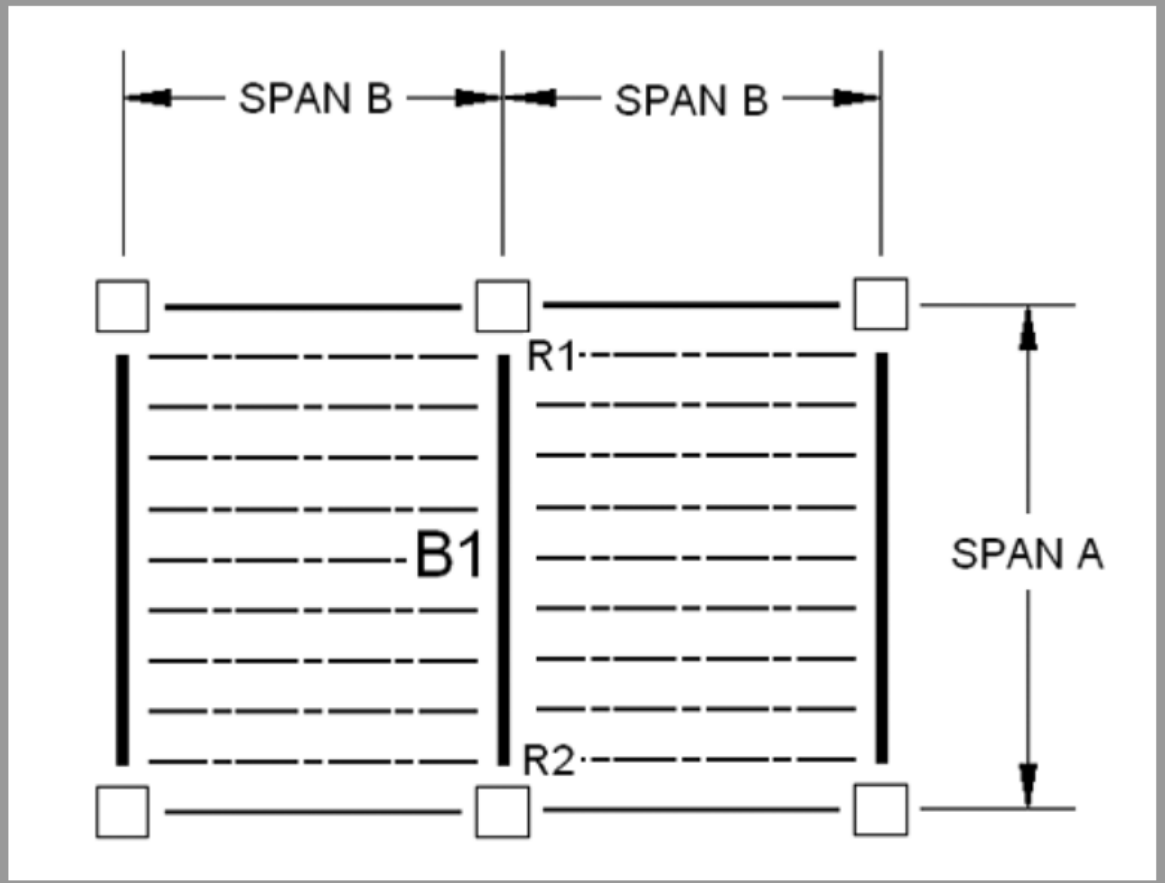
Logged in as: Faezeh Choobkar

5. Steel Beam Design

Choose the lightest steel W-section to support the applied dead and live floor loads on Beam B1. Choose a steel W-section from AISC Table 3-2 (posted on Canvas). For the selection of the beam, neglect selfweight (for loads marked with *). After selecting the lightest section from Table 3-2, revise the DL to include the beam selfweight. Check that the final Mu including selfweight is less than the beam strength, phi Mn. Assume the beam is fully braced, Lb < Lp.

DATASET: 1 -2- -3-

Fy	50 KSI
Span A	25 FT
Span B	17 FT
Floor Dead Load	14 PSF
Floor Live Load	90 PSF



Lightest section?

At first neglect beam self weight
The beam is fully braced ⇒ ZONE 1

#	Question	Your Response	Correct Answer	Score
1	The unfactored floor dead load on beam B1 (neglecting selfweight), w_DL*	238 PLF	238 PLF	5
2	The unfactored floor live load on the beam, w_LL	1530 PLF	1530 PLF	5
3	The total factored design load on the beam (neglecting selfweight), wu*	2.73 KLF	2.7336 KLF	5
4	The factored design moment (neglecting selfweight), Mu*	213.28 K-FT	213.5625 K-FT	5
5	The nominal bending moment (neglecting selfweight), Mn*	2843.73 K-IN	2847.5 K-IN	5
6	The plastic modulus of the section (neglecting selfweight), Zx*	56.87 IN3	56.95 IN3	5
7	The nominal depth of the lightest passing W-section from Zx table (include selfweight)	IN	SUBMIT	
8	The weight of the lightest passing W-section from Zx table	58 PLF	35 PLF	0
9	The plastic modulus of the section for the chosen section, Zx	IN3	SUBMIT	
10	The revised unfactored dead load on the beam (including selfweight), w_DL	PLF	SUBMIT	
11	The total factored design load on the beam (including selfweight), wu	KLF	SUBMIT	
12	The factored design moment (including selfweight), Mu in KIP-FT	K-FT	SUBMIT	
13	The factored design moment (including selfweight), Mu in KIP-IN	K-IN	SUBMIT	
14	The nominal factored bending moment for the chosen section, phi Mn	K-IN	SUBMIT	

Unfactored Floor Dead load on beam B7:

$$w_D = 14 \frac{\text{PSF}}{} \times 2 \left(\frac{\text{Span B}}{2} \right) = 238 \text{ PLF}$$

live load:

$$w_L = 90 \times 17 = 1530 \text{ PLF}$$

$w_u \rightarrow$ Total factored Design load

$$w_u = 1.2\, w_D + 1.6\, w_L$$

$$w_u = 1.2(238) + 1.6(1530) = 285.6 + 2448 \Rightarrow$$

$$w_u = 2733.6 \times \frac{1}{1000} = 2.73 \text{ KLF}$$

$$M_u = \frac{w_u \ell^2}{8} = \frac{2.73(25)^2}{8} = 213.28 \text{ k-FT}$$

$$M_u \leq \phi M_n$$

Assume : $M_u = \phi M_n \rightarrow$ we want to use the maximum capacity

$$\phi = 0.9$$

$$M_n = \frac{M_u}{\phi} = \frac{213.28}{0.9} = 236.97 \text{ k-FT} \times 12 = 2843.73 \text{ k-IN}$$

Zone 1:

$M_n = Z_x F_y \rightarrow 2843.73 = Z_x (50)$

$Z_x = 56.87$

based on the Table 3-2:

W18 X 35

Z_x

Table 3-2 (continued)
W-Shapes
Selection by Z_x

F_y = 50 ksi

Shape	Z_x	M_{px}/Ω_b	$\phi_b M_{px}$	M_{rx}/Ω_b	$\phi_b M_{rx}$	BF/Ω_b	$\phi_b BF$	L_p	L_r	I_x	V_{nx}/Ω_v	$\phi_v V_{nx}$
		kip-ft	kip-ft	kip-ft	kip-ft	kips	kips				kips	kips
	in.^{3}	ASD	LRFD	ASD	LRFD	ASD	LRFD	ft	ft	in.^{4}	ASD	LRFD
W18×35	**66.5**	**166**	**249**	**101**	**151**	**8.14**	**12.3**	**4.31**	**12.3**	**510**	**106**	**159**
W12×45	64.2	160	241	101	151	3.80	5.80	6.89	22.4	348	81.1	122
W16×36	64.0	160	240	98.7	148	6.24	9.36	5.37	15.2	448	93.8	141
W14×38	61.5	153	231	95.4	143	5.37	8.20	5.47	16.2	385	87.4	131
W10×49	60.4	151	227	95.4	143	2.46	3.71	8.97	31.6	272	68.0	102
W8×58	59.8	149	224	90.8	137	1.70	2.55	7.42	41.6	228	89.3	134
W12×40	57.0	142	214	89.9	135	3.66	5.54	6.85	21.1	307	70.2	105
W10×45	54.9	137	206	85.8	129	2.59	3.89	7.10	26.9	248	70.7	106
W14×34	**54.6**	**136**	**205**	**84.9**	**128**	**5.01**	**7.55**	**5.40**	**15.6**	**340**	**79.8**	**120**
W16×31	**54.0**	**135**	**203**	**82.4**	**124**	**6.86**	**10.3**	**4.13**	**11.8**	**375**	**87.5**	**131**
W12×35	51.2	128	192	79.6	120	4.34	6.45	5.44	16.6	285	75.0	113
W8×48	49.0	122	184	75.4	113	1.67	2.55	7.35	35.2	184	68.0	102
W14×30	**47.3**	**118**	**177**	**73.4**	**110**	**4.63**	**6.95**	**5.26**	**14.9**	**291**	**74.5**	**112**
W10×39	46.8	117	176	73.5	111	2.53	3.78	6.99	24.2	209	62.5	93.7
W16×26[v]	**44.2**	**110**	**166**	**67.1**	**101**	**5.93**	**8.98**	**3.96**	**11.2**	**301**	**70.5**	**106**
W12×30	43.1	108	162	67.4	101	3.97	5.96	5.37	15.6	238	64.0	95.9

Revise dead load and include self weight

$$W_D = 238\ PLF + 35\ PLF = 273\ PLF$$

$$W_u = 1.2(273) + 1.6(1530) = 2775.6 \times \frac{1}{1000} = 2.77\ klf$$

$$M_u = \frac{w_u \ell^2}{8} = \frac{2.77(25)^2}{8} = 216.4 \text{ k-FT}$$

unit Conversion : $216.4 \times 12 = 2596.875$

$$M_n = Z_x F_y = \underline{66.5} \times 50 = 3325$$

↓

based on Table

$$\phi M_n = 0.9(3325) = 2992,5$$

$2992,5 < 2596.875$

- Thanks for your attention ☺