Arch324

STRUCTURES II

Winter 2026
Recitation

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Recitation Guidelines

Homework Problem

Lab (No calculation, just an experiment)

- Please complete the lab sheet during recitation and hand it in before leaving.
- Try to attend all sessions. Unexcused absences will **affect your grade** starting from the second missed class.

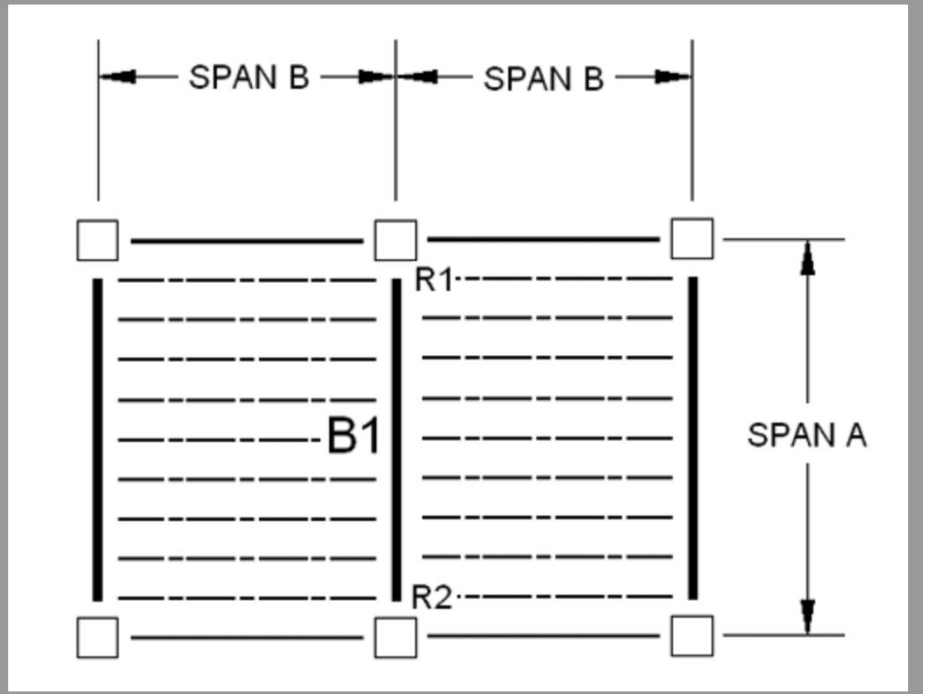
Analysis Example - HW5

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	27 FT
Span B	14 FT
Floor Dead Load	19 PSF
Floor Live Load	90 PSF



Analysis Example - HW5

14 Questions

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

Answer HW5

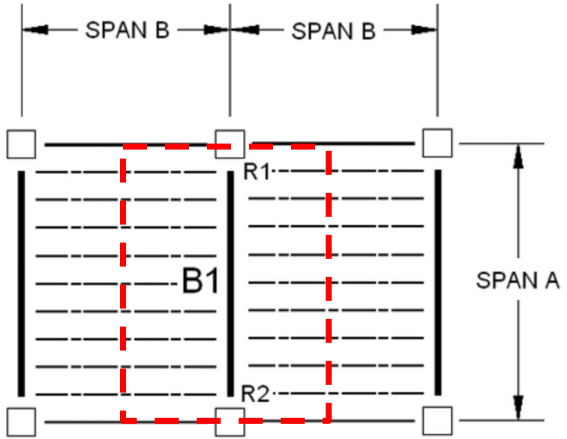
14 Questions

#	Question	Correct Answer
1	The unfactored floor dead load on beam B1 (neglecting selfweight), w_DL*	266 PLF
2	The unfactored floor live load on the beam, w_LL	1260 PLF
3	The total factored design load on the beam (neglecting selfweight), wu*	2.3352 KLF
4	The factored design moment (neglecting selfweight), Mu*	212.7951 K-FT
5	The nominal bending moment (neglecting selfweight), Mn*	2837.268 K-IN
6	The plastic modulus of the section (neglecting selfweight), Zx*	56.74536 IN3
7	The nominal depth of the lightest passing W-section from Zx table (include selfweight)	18 IN
8	The weight of the lightest passing W-section from Zx table	35 PLF
9	The plastic modulus of the section for the chosen section, Zx	66.5 IN3
10	The revised unfactored dead load on the beam (including selfweight), w_DL	301 PLF
11	The total factored design load on the beam (including selfweight), wu	2.3772 KLF
12	The factored design moment (including selfweight), Mu in KIP-FT	216.62235 K-FT
13	The factored design moment (including selfweight), Mu in KIP-IN	2599.4682 K-IN
14	The nominal factored bending moment for the chosen section, phi Mn	2992.5 K-IN

Analysis Example - HW5

Q1-Q3

Span A	27 FT
Span B	14 FT
Floor Dead Load	19 PSF
Floor Live Load	90 PSF

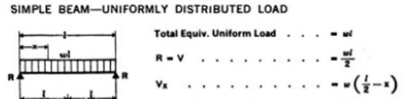


Procedure - Analysis of Steel Beams – **for Zone 1** $L_b < L_p$

Pass/Fail

Given: yield stress, steel section, loading, bracing (L_b)
Find: pass/fail of section

1. Calculate the factored design load w_u
   $w_u = 1.2w_{DL} + 1.6w_{LL}$



Tributary area $= \left(\frac{\text{Span B}}{2} + \frac{\text{Span B}}{2}\right) \cdot \text{Span A} = \left(\frac{14}{2} + \frac{14}{2}\right) \times 27 = 378\ FT^2$

Q1 $W_{DL}^* = \text{Floor DL}\left(\frac{\text{Tributary area}}{\text{Span A}}\right) = 19\left(\frac{378}{27}\right) = 266\ PLF$

Q2 $W_{LL} = \text{Floor LL}\left(\frac{\text{Tributary area}}{\text{Span A}}\right) = 90\left(\frac{378}{27}\right) = 1260\ PLF$

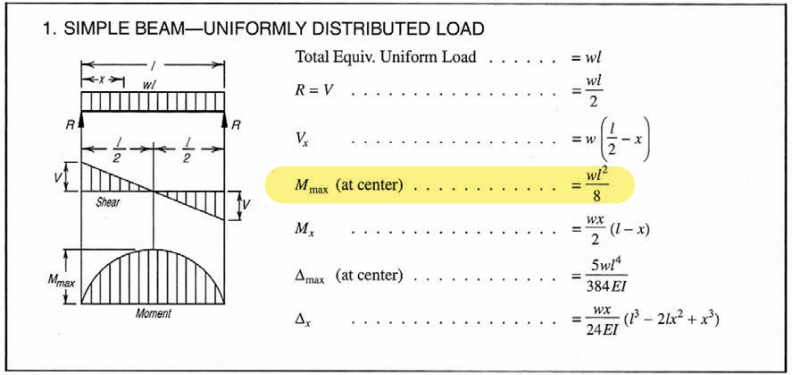
Q3 $W_u^* = 1.2W_{DL}^* + 1.6W_{LL} = 1.2 \times 266 + 1.6 \times 1260 = 2335.2\ PLF$
$= 2.3352\ KLF$

Analysis Example - HW5

Q4-Q5

Design of Steel Beam – Procedure (zone 1)

1. Use the maximum moment equation, and solve for the ultimate moment, M_u.
2. Set $\phi M_n = M_u$ and solve for M_n



1. SIMPLE BEAM—UNIFORMLY DISTRIBUTED LOAD

Total Equiv. Uniform Load	$= wl$
$R = V$	$= \frac{wl}{2}$
V_x	$= w\left(\frac{l}{2} - x\right)$
M_{max} (at center)	$= \frac{wl^2}{8}$
M_x	$= \frac{wx}{2}(l - x)$
Δ_{max} (at center)	$= \frac{5wl^4}{384EI}$
Δ_x	$= \frac{wx}{24EI}(l^3 - 2lx^2 + x^3)$

Span A=27 FT

Q4 $M_u^* = \frac{W_u^* \cdot l^2}{8} = \frac{2.3352\ (27)^2}{8} = 212.7951$ K-FT

Q5 $\phi M_n = 0.9 \cdot M_n^* = 212.7951 \rightarrow M_n^* = \frac{212.7951}{0.9} \times 12 = 2837.268$ K-IN

Transfer to inch

Analysis Example - HW5

Fy 50 KSI

Q6-Q9 AISC14_Table3-2

3. Assume Zone 1 to determine Z_x required
4. Select the lightest beam with a Z_x greater than the Z_x required from AISC table

Q6 $Z_x^* = \frac{Mn^*}{Fy} = \frac{2837.268}{50} = 56.74536\ in^3$

→ select W18 X 35

Q7 Q8

Q9 Zx=66.5 in³

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

Find the region in the **ZX** column where **ZX > 56.7** (blue region), then within this region identify the lightest beam (red region). **35** is the smallest of the right-hand values in the **Shape** column, so it is the lightest.

Analysis Example - HW5

Q10-Q14