Recitation 5

Steel Beam Design

Homework problem

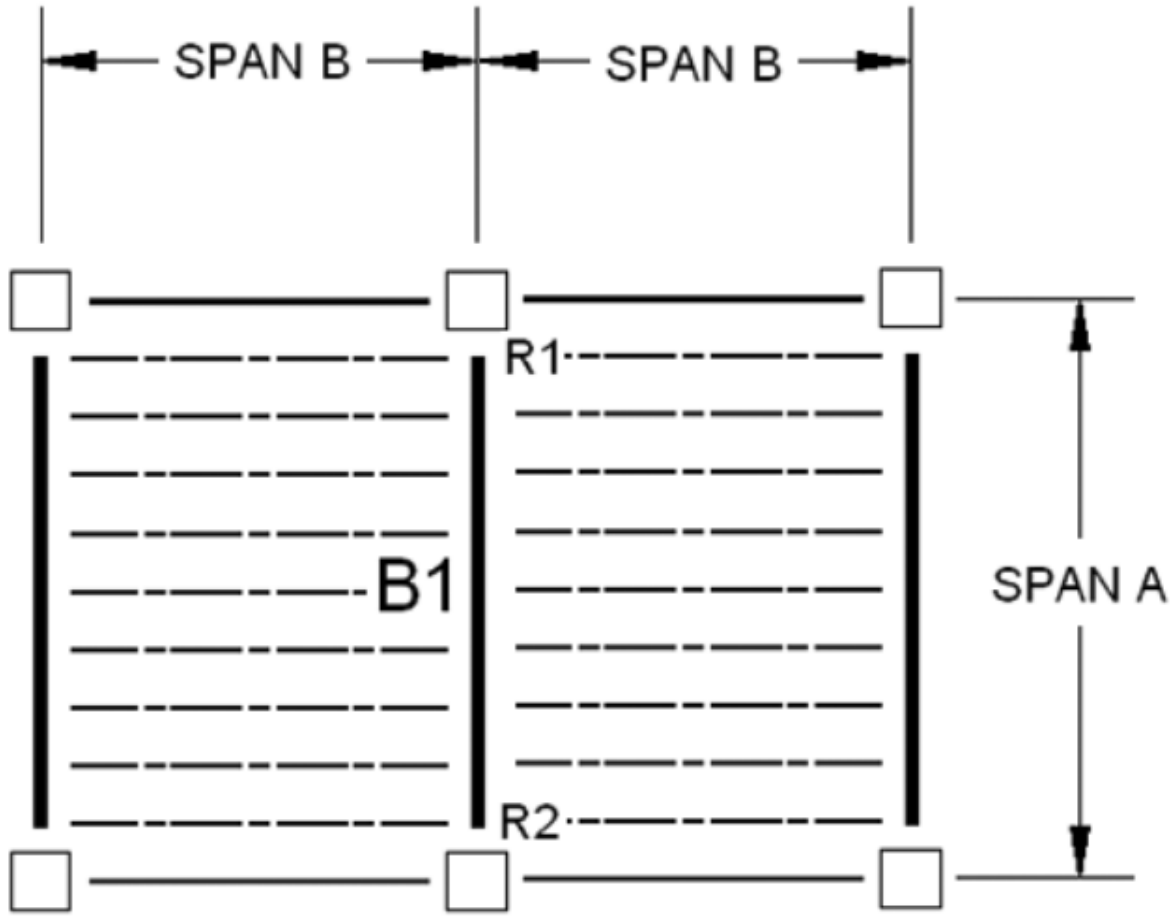
Steel Beam Design

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-

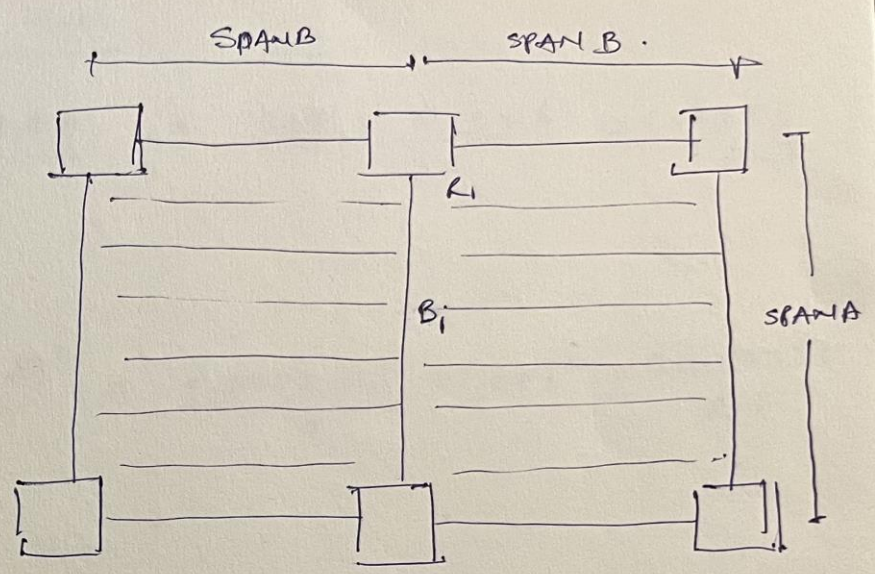
Fy	50 KSI
Span A	27 FT
Span B	14 FT
Floor Dead Load	19 PSF
Floor Live Load	90 PSF



Q1). Steel Beam Design :- Home work problem

Choose the lightest steel W-section to support the applied Dead load and live floor loads on Beam B_1.

- Neglect self weight.
- select lightest section
- Use table 3.2 from AISC (after this).
- revise DL to include the beam self weight.
- Check that final M_u including self weight is less than the beam strength. (ϕM_n).
- Assume beam fully braced ($L_b < L_p$).



$F_y = 50$ KSI

SPAN A = 27 FT

SPAN B = 14 FT

floor Dead Load = 19 PSF

floor live load = 90 PSF

Q1) The unfactored dead load on Beam B_1 (neglecting self weight), w_DL^* :-

$$w\_DL^* = \text{span } B \times \text{Floor Dead Load}$$
$$= 14 \times 19 = 266 \text{ PLF}$$

Q2) The unfactored floor live load on Beam, w_LL :-

$$w\_LL = \text{span } B \times \text{floor live load}$$
$$= 14 \times 90 = 1260 \text{ PLF}$$

Q3) The total factored design load on the beam (neglecting selfweight), W_U^* :-

$$W_U^* = \frac{1.2 \times W_{-DL}^* + 1.6 \times W_{-LL}}{1000}$$

(divided by 1000 to convert LB → KLF)

$$= \frac{1.2 \times 266 + 1.6 \times 1260}{1000} = \frac{319.2 + 2016}{1000} = 2.3352 \text{ KLF}$$

Q4) factored Design moment, M_U^* :-

$$M_U^* = \frac{W_U^* l^2}{8} = \frac{W_U^* \times (\text{span } A)^2}{8} = \frac{2.3352 \text{ KLF}}{8} \times (27)^2 = 212.7951 \text{ K-FT}$$

Q5) The Nominal Bending Moment, M_n^* :-

$$M_n^* = \frac{M_U^* \times 12}{0.9} = \frac{212.7951 \times 12}{0.9} = 2837.268 \text{ K-IN}$$

(Multiply by 12 to convert FT → in)

Q6) The plastic Modulus of section (neglecting self weight) :- (Z_x^*).

$$Z_x^* = \frac{M_n^*}{f_y} = \frac{2837.268 \text{ K-IN}}{50} = 56.74536 \text{ IN}^3$$

Q7) The nominal depth of the lightest passing W-section from Z_x table (include self weight) :-

The most closest and greater Z_x from table is $66.5\ IN^3$

∴ W section we'll be using – W18×35

∴ Nominal Depth = 18 IN

Q8) The weight of the lightest passing W-section from Z_x table :-

W 18 × 35 , weight = 35 PLF

beam selfweight

Q9) The plastic modulus of the section for the chosen section, Z_x :-

$Z_x = 66.5\ IN^3$.

Q10) The revised unfactored dead load on the beam (including self weight), w_DL

from (Q8). from (Q1)

W_DL = beam self weight + W*_DL

= 35 + 266 = 301 PLF

for questions 7-9 use table 3.2. Based on Z_x from Q6 chose Z_x from table which is greater than Q6 value and closet to it. Based on that you'll get size of lightest passing W-section.

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

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

F_y = 50 ksi

Z_x

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
W12×16	**20.1**	**50.1**	**75.4**	**29.9**	**44.9**	**3.80**	**5.73**	**2.73**	**8.05**	**103**	**52.8**	**79.2**
W10×17	18.7	46.7	70.1	28.3	42.5	2.98	4.47	2.98	9.16	81.9	48.5	72.7
W12×14[v]	**17.4**	**43.4**	**65.3**	**26.0**	**39.1**	**3.43**	**5.17**	**2.66**	**7.73**	**88.6**	**42.8**	**64.3**
W8×18	17.0	42.4	63.8	26.5	39.9	1.74	2.61	4.34	13.5	61.9	37.4	56.2
W10×15	16.0	39.9	60.0	24.1	36.2	2.75	4.14	2.86	8.61	68.9	46.0	68.9
W8×15	13.6	33.9	51.0	20.6	31.0	1.90	2.85	3.09	10.1	48.0	39.7	59.6
W10×12[f]	**12.6**	**31.2**	**46.9**	**19.0**	**28.6**	**2.36**	**3.53**	**2.87**	**8.05**	**53.8**	**37.5**	**56.3**
W8×13	11.4	28.4	42.8	17.3	26.0	1.76	2.67	2.98	9.27	39.6	36.8	55.1
W8×10[f]	**8.87**	**21.9**	**32.9**	**13.6**	**20.5**	**1.54**	**2.30**	**3.14**	**8.52**	**30.8**	**26.8**	**40.2**

Q11) Total factored Design load on the beam :-
(including selfweight), Wu

$$W_u = \frac{1.2\, W\_DL + 1.6\, W\_LL}{1000}$$

$$= \frac{1.2\,(301) + 1.6\,(1260)}{1000} = \frac{361.2 + 2016}{1000} = 2.3772 \text{ KLF}$$

Q12) The factored design moment (including selfweight), Mu in KIP-FT, -

$$M_u = \frac{W_u l^2}{8} = \frac{\overset{(Q11)}{W_u} \times (\text{span } A)^2}{8}$$

$$= \frac{2.3772 \times (27)^2}{8} = 216.62235 \text{ K-FT.}$$

Q13) The factored design moment. (including selfweight) Mu in KIP-IN :-

$$M_u = \overset{(Q12)}{M_u} \times \frac{12\text{in}}{1\text{FT}} = 216.62235 \times 12. = 2599.4682 \text{ K-IN.}$$

Q14) The nominal factored bending moment for the chosen section, phi Mn :-

$$\phi M_n = 0.9\,(F_y)(Z_{xc}) = 0.9 \times 50 \times 66.5$$

$$= 2992.5 \text{ K-IN.}$$

Thankyou !!!