Arch324

STRUCTURES II

Winter 2026
Recitation

FACULTY: Prof. Peter von Bülow
GSI: Hui Zhu huizz@umich.edu

Recitation Guidelines

Homework Problem

Lab

- 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.

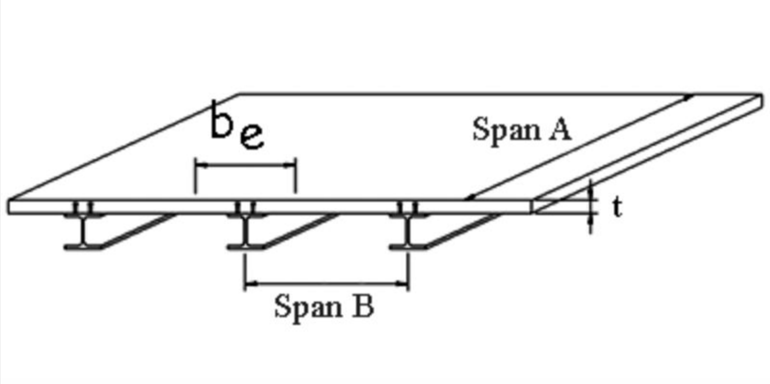
Analysis Example - HW10

10. Composite Sections

Analyze the given composite floor system. Determine the depth of the compression block, a. Find the floor live load capacity.

DATASET: 1 -2- -3-

W-section	W16X77
span A	48 FT
span B	13 FT
slab thickness, t	5 IN
steel yield stress, Fy	50 KSI
concrete ultimate stress, f'c	6 KSI



Answer HW10

11 Questions

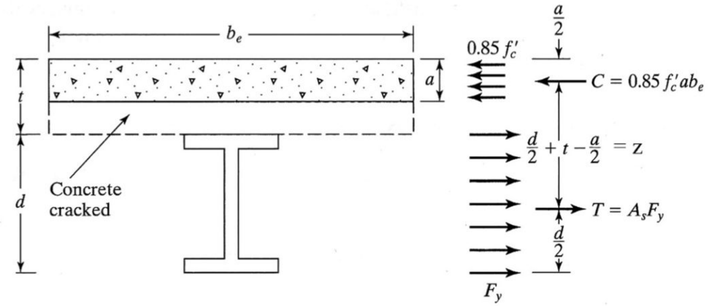
#	Question	Correct Answer	
1	Effective width of the concrete flange, be	90.3	IN
2	Depth of concrete stress block, a	2.453694656	IN
3	Is depth a within the slab? 1=yes, 0=no	1	
4	The nominal bending moment, Mn	13586.16252	K-IN
5	The factored bending resistance, phi Mn	12227.54627	K-IN
6	The factored design moment, Mu	1018.962189	K-FT
7	The total factored design load, wu	3.538063156	KLF
8	The selfweight of the concrete slab	62.5	PSF
9	The total (steel+concrete) unfactored dead load on the beam, w_DL	0.8895	KLF
10	The actual, unfactored beam live load (capacity), w_LL	1.544164473	KLF
11	The actual floor live load (floor capacity), LL	118.7818825	PSF

Analysis Example - HW10

Analysis Procedure (LRFD)

Case1 – PNA within slab

Given: Slab and beam geometry
W-section size and steel grade
(floor loads)
Find: pass/fail or capacities



1. Define effective flange width, b_e

2. Calculate the effective depth of the concrete stress block, a

3. If a is within concrete slab, the full steel section is in tension and:
   Mp = T z
   Mn = Mp = As Fy (d/2 + t - a/2)

4. Mu ≤ ϕ Mn

$$T = C$$

$$A_s f_y = 0.85 f_c' \, a \, b_e$$

$$a = \frac{A_s f_y}{0.85 f_c' \, b_e}$$

Analysis Example - HW10

Q1

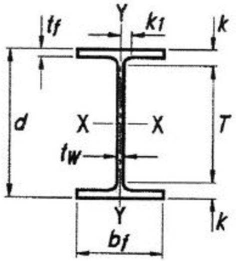


Table 1-1 (continued)
W-Shapes
Dimensions

Shape	Area, A	Depth, d		Web Thickness, t_w		Web $\frac{t_w}{2}$	Flange Width, b_f		Flange Thickness, t_f		Distance k k_{des}	Distance k k_{det}	k_1	T	Workable Gage
	in.^{2}	in.		in.		in.	in.		in.		in.	in.	in.	in.	in.
W16×100	29.4	17.0	17	0.585	9/16	5/16	10.4	10 3/8	0.985	1	1.39	1 7/8	1 1/8	13 1/4	5 1/2
×89	26.2	16.8	16 3/4	0.525	1/2	1/4	10.4	10 3/8	0.875	7/8	1.28	1 3/4	1 1/16		
×77	22.6	16.5	16 1/2	0.455	7/16	1/4	10.3	10 1/4	0.760	3/4	1.16	1 5/8	1 1/16		
×67[c]	19.6	16.3	16 3/8	0.395	3/8	3/16	10.2	10 1/4	0.665	11/16	1.07	1 9/16	1		
W16×57	16.8	16.4	16 3/8	0.430	7/16	1/4	7.12	7 1/8	0.715	11/16	1.12	1 3/8	7/8	13 5/8	3 1/2[g]
×50[c]	14.7	16.3	16 1/4	0.380	3/8	3/16	7.07	7 1/8	0.630	5/8	1.03	1 5/16	13/16		
×45[c]	13.3	16.1	16 1/8	0.345	3/8	3/16	7.04	7	0.565	9/16	0.967	1 1/4	13/16		
×40[c]	11.8	16.0	16	0.305	5/16	3/16	7.00	7	0.505	1/2	0.907	1 3/16	13/16		
×36[c]	10.6	15.9	15 7/8	0.295	5/16	3/16	6.99	7	0.430	7/16	0.832	1 1/8	3/4		

AISC14_Table1-1

A=22.6 in²
d=16.5 in
bf=10.3 in

Analysis Example - HW10

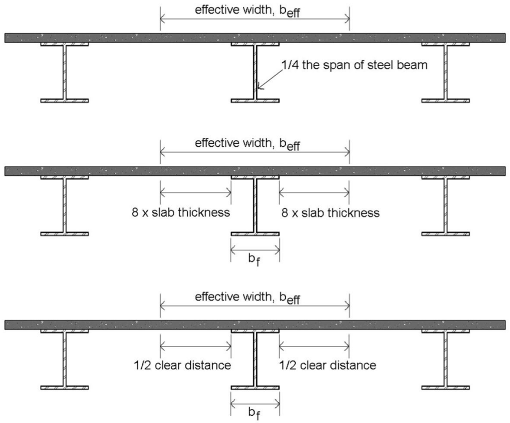
Q1-3

Effective Flange Width, b_e

Slab on both sides:

b_e is the **least** total width :

- Total width: ¼ of the beam span
- Overhang: 8 x slab thickness
- Overhang: ½ the clear distance to next beam (i.e. b_e is the web on center spacing)



transfer to inch

$$b_{eff} = \min \begin{cases} \frac{1}{4} \times \text{Span } A = \frac{1}{4}(48 \times 12) = 144'' \\ b_f + 2(8t) = 10.3 + 2(8 \times 5) = 90.3'' \; ✓ \\ b_f + 2\left(\frac{1}{2}\text{Span } B\right) = 10.3 + 2\left(\frac{1}{2} \times 13 \times 12\right) = 166.3'' \end{cases}$$

Q1

$$a = \frac{A_s \cdot F_y}{0.85 \cdot f'_c \cdot b_e} = \frac{22.6 \times 50}{0.85 \times 6 \times 90.3} = 2.454'' < 5'' = t$$

Q2

$\rightarrow$ within slab

Q3

Analysis Example - HW10

Q3-9

3. If a is within concrete slab, the full steel section is in tension and:

   Mp = T z

   Mn = Mp = As Fy (d/2 + t - a/2)

4. Mu ≤ ϕ Mn

Q4

$$M_n = M_p = A_s \cdot F_y \left(\frac{d}{2} + t - \frac{a}{2}\right)$$

$$= 22.6 \times 50 \left(\frac{16.5}{2} + 5 - \frac{2.454}{2}\right) = 13585.99 \text{ K-IN}$$

Q5

$$\phi M_n = 0.9\, M_n = 0.9\,(13585.99) = 12227.391 \text{ K-IN}$$

Q6

$$M_u = 12227.391 \times \frac{1}{12} = 1018.95 \text{ K-FT}$$

transfer to feet ×1/12

$$M_u = \frac{W_u \cdot L^2}{8} = \frac{W_u \cdot (\text{Span A})^2}{8} = \frac{W_u \cdot (48)^2}{8} = 1018.95$$

Q7

$$\rightarrow W_u = \frac{12227.391}{12} \times \frac{8}{(48)^2} = 3.538 \text{ KLF}$$

transfer to feet

reinforced concrete density=150lb/ft³

Q8

weight of concrete slab: $\frac{t}{12} \times 150 = \frac{5}{12} \times 150 = 62.5$ PSF

Q9

$$W_{DL} = 13'' \times 62.5 + 77 = 889.5 \text{ PLF} = 0.8895 \text{ KLF}$$

Tributary area width = Span B

W16×77 → Weight of steel=77 lb/ft

Analysis Example - HW10

Q10-11

Q10

$$W_u = 1.2 W_{DL} + 1.6 W_{LL}$$

$$3.538 = 1.2(0.8895) + 1.6 W_{LL}$$

$$\longrightarrow W_{LL} = \frac{3.538 - 1.2(0.8895)}{1.6} = 1.544 \text{ KLF}$$

Q11

$$\frac{W_{LL}}{\text{Span } B} = \frac{1.544 \times 1000}{13} = 118.769 \text{ PSF} = LL$$

transfer to PLF