Composite Sections 4/5

HW – Composite Sections

Structure II
Section 004

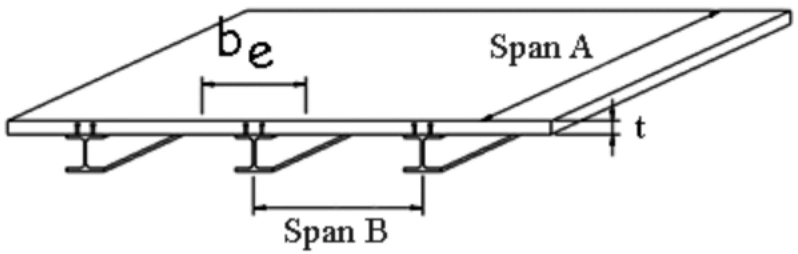
Yifan Ma
yifanma@umich.edu

10. Composite Sections

Using the strength method, determine the required amount of flexural steel reinforcement, As, for the simple span beam (shown in section). The beam carries a dead and live floor load from a one-way slab in addition to its own self weight at 150 PCF. For the given bar size, determine the number of bars to obtain the required As. Check As,min and epsilon_t. Calculate the strength moment, Mn for the final beam design and check that phi Mn is > Mu.

DATASET: 1 -2- -3-

W-section	W16X77
span A	49 FT
span B	11 FT
slab thickness, t	6 IN
steel yield stress, Fy	50 KSI
concrete ultimate stress, f'c	3 KSI

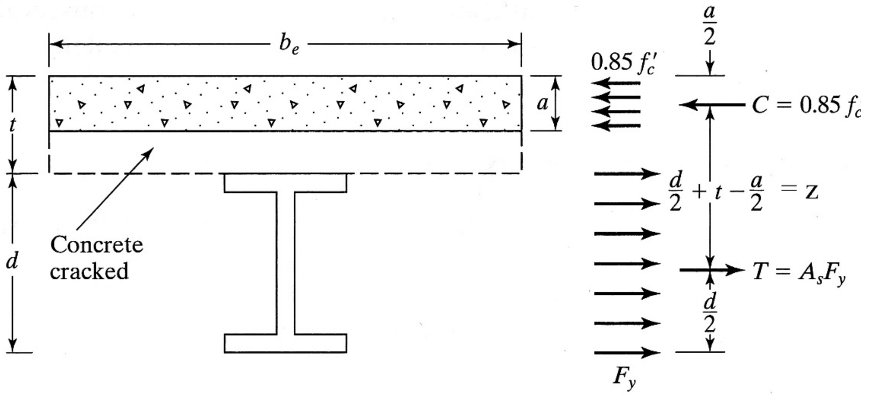


Data:

Slab and beam geometry

W-section size and steel grade(floor loads)

1. Determine effective flange width, be
2. Calculate the effective depth of the concrete stress block, a

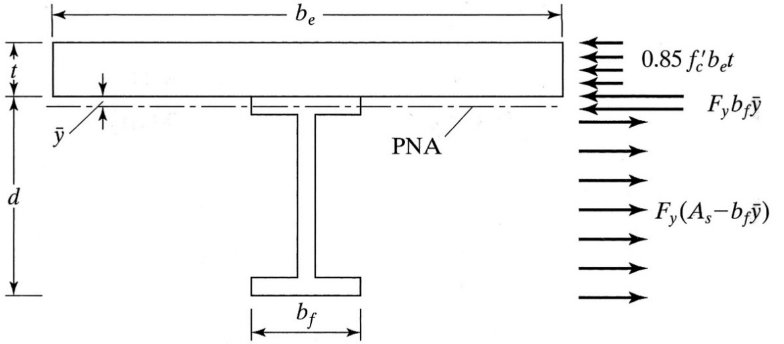


3. If a is within concrete slab, the full steel section is in tension and:
   Mn = Mp = As Fy (d/2 + t - a/2)

4. Mu ≤ ϕ Mn

5. Use Mu to calculate factored loads with appropriate beam moment equation.

Required:
Capacities



3. If a is within steel section, the part below the Plastic Neutral Axis (PNA) is in tension and everything above the PNA is in compression (the steel and the concrete)

4. Check if PNA falls within flange or web of the W-section

5. Find $\bar{y}$ by equating T = C

6. Mn = Mp = C1(z1) + C2(z2) + T(z3)

7. Mu = ϕ Mn

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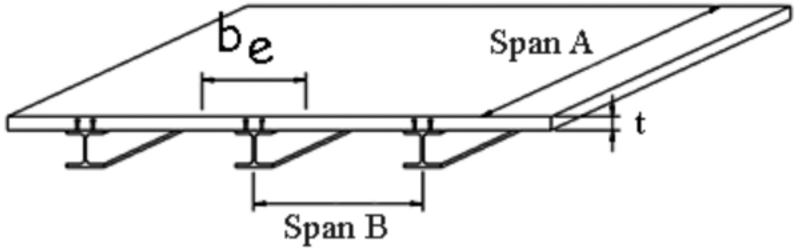


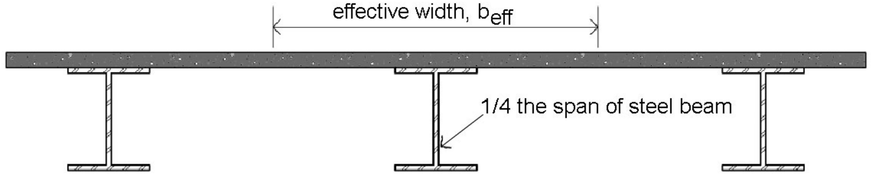
1. Effective width of the concrete flange, be

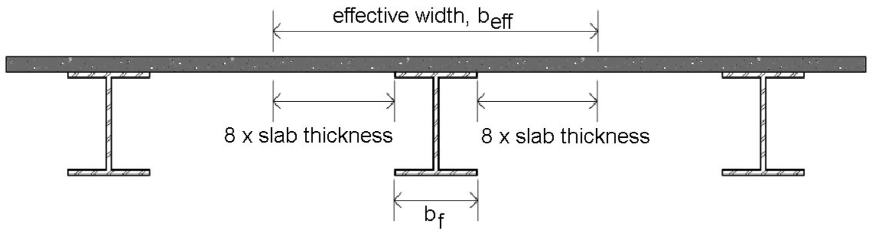
be is the least total width :

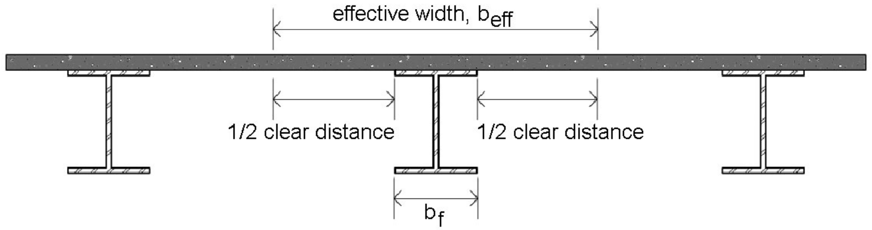
(1) Total width: ¼ of the beam span

(2) Overhang: 8 x slab thickness

(3) Overhang: ½ the clear distance to next beam (i.e. be

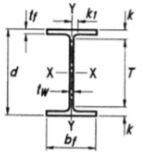






AISC14 Table 1-1

Table 1-1 (continued)
W-Shapes
Dimensions



Shape	Area, A	Depth, d		Web Thickness, t_w		$\frac{t_w}{2}$	Flange Width, b_f		Flange Thickness, t_f		Distance k k_{des}	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	↓	↓

(1) ¼ * span A = ¼ x 49 *12= 147 in

(2) 8 * t *2 + flange width = 8 x 6 x 2 + 10.3 = 106.3 IN

(3) Span B =11 FT = 121 IN

be = 106.3 in

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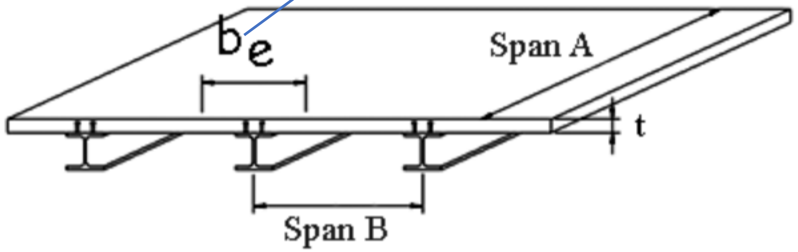

2. Depth of concrete stress block,a

$$a = \frac{A_s f_y}{0.85 f'_c b}$$ = 22.6*50000/ (0.85*3000* 106.3)= 4.17 in

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
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3. Is depth a within the slab? 1 = yes, 0 = no

a =4.17 in < t =6 in, 1

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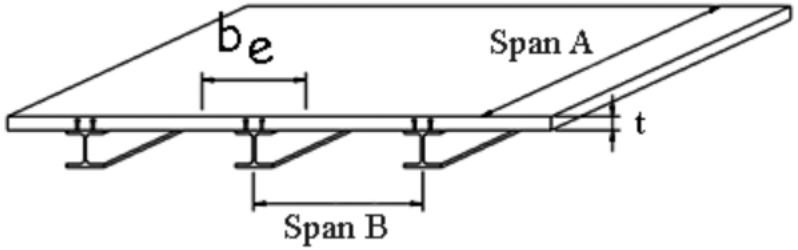
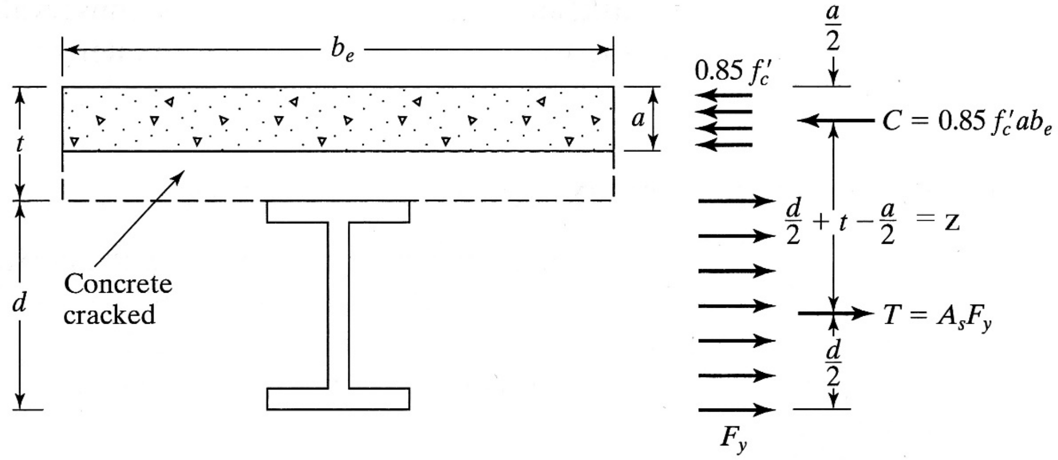


4. The nominal bending moment, Mn



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×67[c]	19.6	16.3	16 3/8	0.395	3/8	3/16	10.2	10 1/4	0.66

Mn = As * Fy* (d/2 + t –a/2) = 22.6 x 50 x (16.5 / 2 + 6 - 4.17/2) = 13746.45 k-in

5. The factored bending resistance, phi Mn

ϕ * Mn = 0.9 x 13746.45 = 12371.81 k-in

6. The factored design moment, Mu

Mu ≤ ϕ Mn

Mu = ϕ * Mn = 12371.81/12 = 1030.98 k-ft

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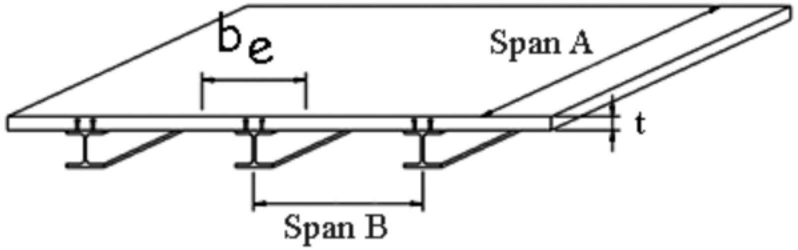

7. The total factored design load, wu

Mu = wu*(SpanA^2)/8

wu= 8 * Mu / (SpanA^2) = 8 x 1030.98 / (49^2) = 3.435(KLF)

8. The self weight of the concrete slab

t * 150(PCF) = 6 / 12 x 150 = 75 (PSF)

9. The total (steel+concrete) unfactored dead load on the beam, w_DL

w_DL= weight of the concrete slab * Span B + beam weight

= (75*11+77) /1000 = 0.902 klf

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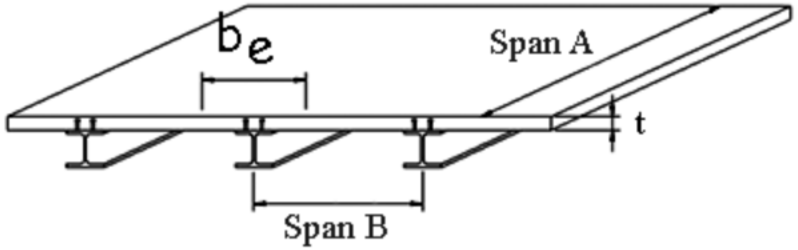


10. The actual, unfactored beam live load(capacity),w_LL

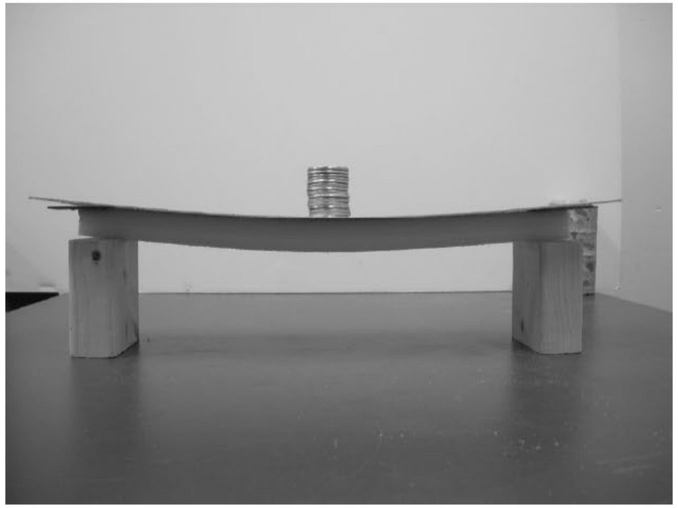
wu = 1.2*DL + 1.6*LL = 3.435 klf

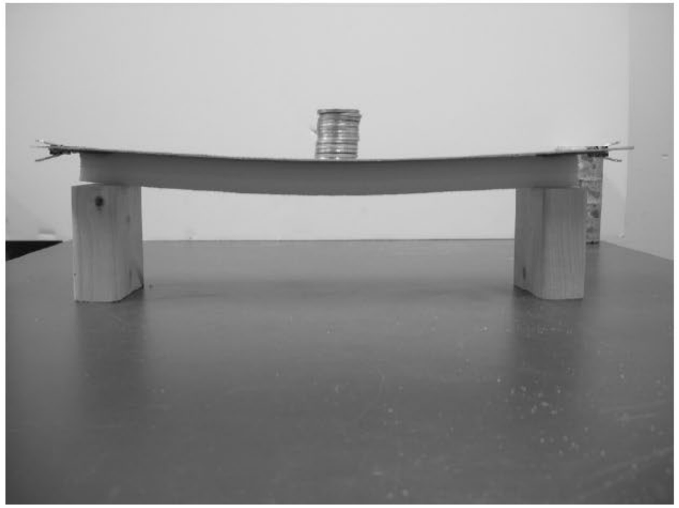
w_LL= (wu–1.2*wDL)/1.6 = (3.435-1.2*0.902)/1.6 = 1.47 klf

11. The actual floor live load(floor capacity),LL

LL = w_LL / SpanB= 1.47/11 *1000 = 133.63 psf

LAB - Composite Sections





Description

This project allows the students to observe the difference in stiffness between Composite and Non-Composite beam slab combinations

Goals

To observe the bending behavior of non-connected beams and slabs
To observe the bending behavior of a composite section.
To compare the deflection of the two systems.

Procedure

1. Place the chipboard slab on the foam beam but do not attach the end clips.
2. Place the 10 washer weights in the center and measure the deflection.
3. Repeat the procedure but now with the ends of the slab and the beam clipped together.
4. Again, measure the deflection.
5. Compare the deflections of the two systems.

Any Questions?

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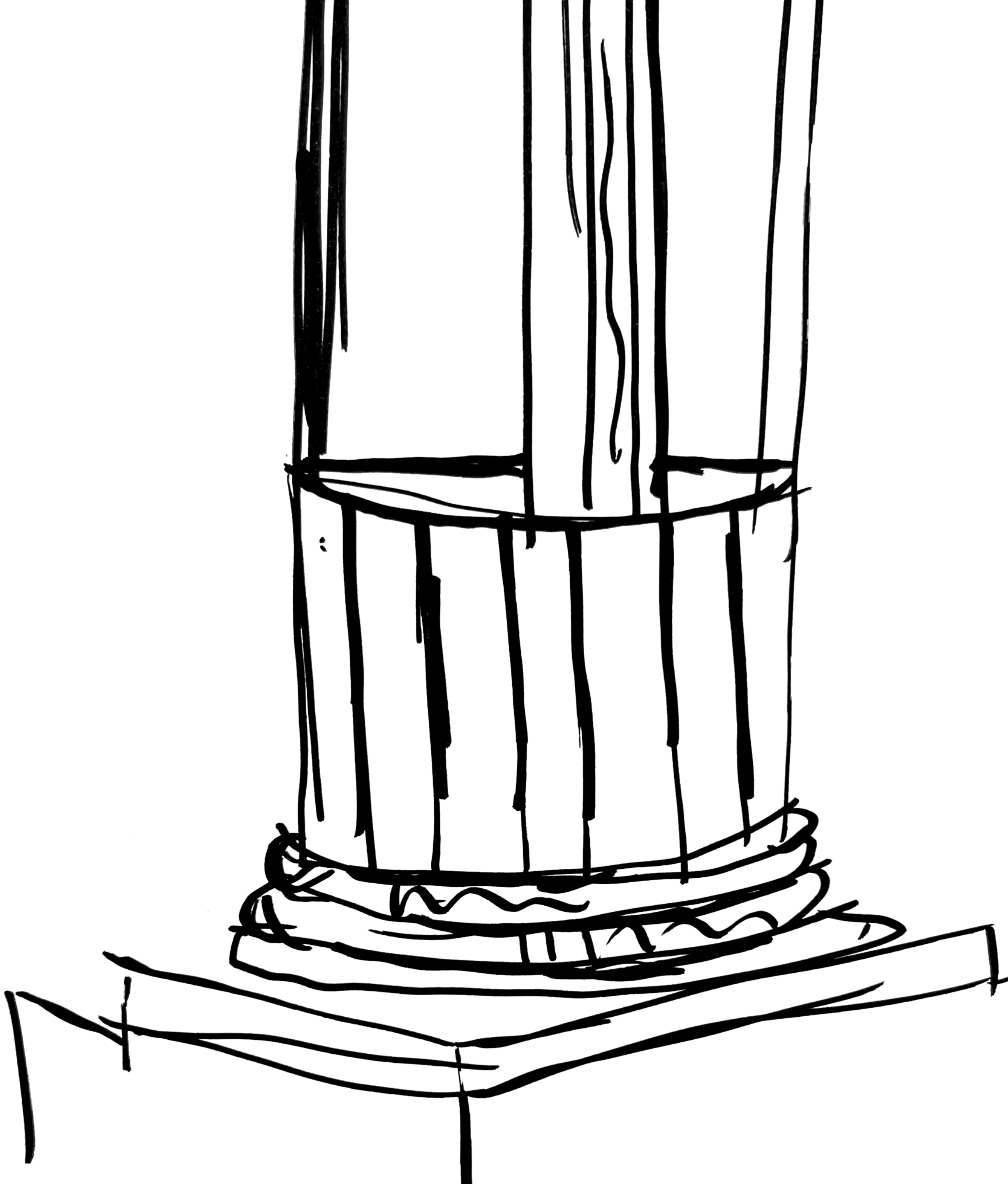

Thank You!