Recitation 11

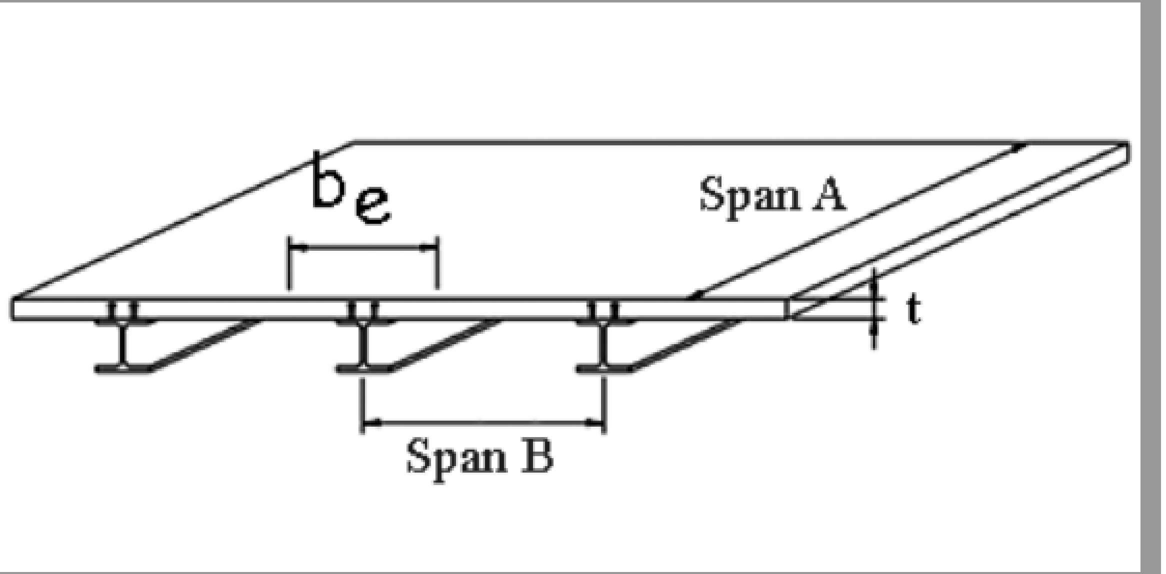
Composite Sections

Homework problem

Composite Sections

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

Q10) Composite Sections :-

W-section :- W 16 × 77

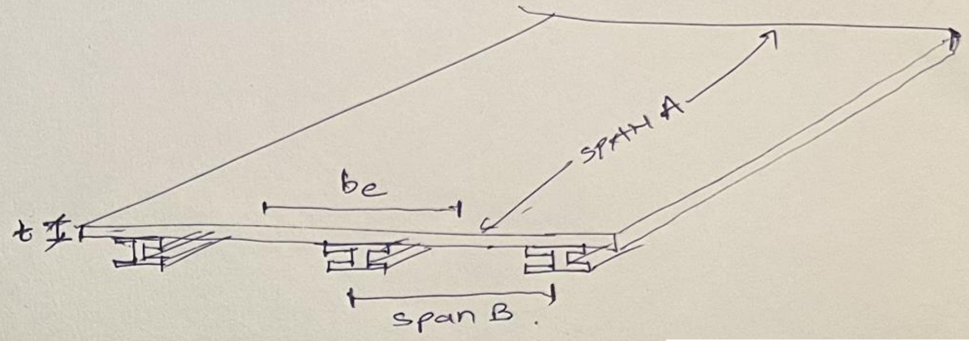
SPAN A :- 48 FT

SPAN B :- 13 FT

Slab thickness, t = 5 IN

Steel yield stress, F_y = 50 KSI

Concrete ultimate stress, f'_c = 6 KSI

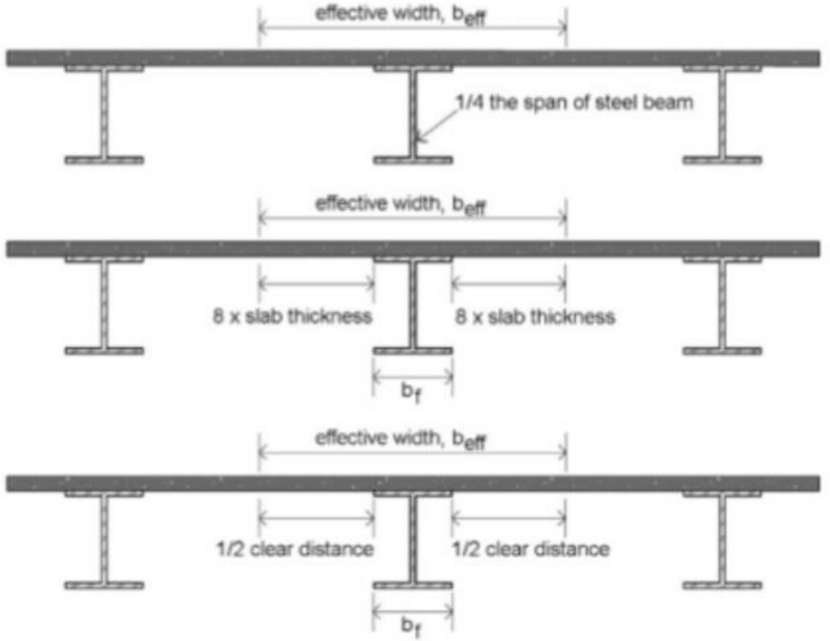


1) Effective width of concrete flange, (b_e) :-

b_e is the least total width (overhang + steel flange) of the equations →

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)



(a) Total width $= 1/4 \times (\text{span A}) \times \frac{12\text{ in}}{\text{FT}}$

$= \frac{1}{4} \times 48\text{ ft} \times \frac{12\text{ in}}{1\text{ FT}} = \boxed{144\text{ in}}$ ←

(b) Total width = → (Table 1-1 AISC table)

$= 2 \times 8 \times (t) + (b_f)$

$= 2 \times 8 \times 5 + 10.3 = \boxed{90.3\text{ in}}$ ← (*) least value governs.

(c) Total width $= \text{span B} \times \frac{12\text{ in}}{1\text{ ft}} =$

$= 13 \times \frac{12}{1\text{ ft}} = \boxed{156\text{ in}}$ ←

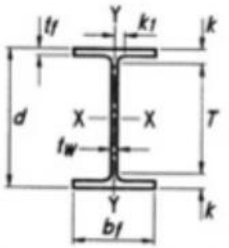


Table 1-1 (continued)
W-Shapes
Dimensions

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		

Table 1-1 (continued)
W-Shapes
Properties

W16-W14

Nominal Wt.	Compact Section Criteria $\frac{b_f}{2t_f}$	$\frac{h}{t_w}$	Axis X-X I	S	r	Z	Axis Y-Y I	S	r	Z	r_{ts}	h_o	Torsional Properties J	C_w
lb/ft			in.⁴	in.³	in.	in.³	in.⁴	in.³	in.	in.³	in.	in.	in.⁴	in.⁶
100	5.29	24.3	1490	175	7.10	198	186	35.7	2.51	54.9	2.92	16.0	7.73	11900
89	5.92	27.0	1300	155	7.05	175	163	31.4	2.49	48.1	2.88	15.9	5.45	10200
77	6.77	31.2	1110	134	7.00	150	138	26.9	2.47	41.1	2.85	15.7	3.57	8590
67	7.70	35.9	954	117	6.96	130	119	23.2	2.46	35.5	2.82	15.6	2.39	7300

From table 1-1, W 16×77, Area = 22.6 in²
b_f = 10.3 in
Wt/ft = 77 lb/ft.
Depth (d) = 16.5 in.

Q2) Depth of concrete stress block (a) :-

from table 1-1, A_s = 22.6 in²

from $a = \frac{A_s f_y}{0.85 f'_c b_e} = \frac{22.6 \text{ in}^2 \times 50 \text{ k/in}^2}{0.85 \times 6 \text{ k/in}^2 \times 10.3 \text{ in}}$

5 → (slab thickness).

∴ $a = 2.4537$ in < 5 in
∴ (within slab) → Q3 mention (1)

Q4) Nominal bending Moment (M_n):-

Q5) The factored bending Resistance, phiMn :-

Q6) The factored design Moment, M_u :-

from table 1.1 (W 16 × 77); d = 16.5 in

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

$$= 22.6 \text{ in}^2 \times 50 \frac{k}{\text{in}^2} \left(\frac{16.5}{2} + 5 - \frac{2.4537}{2} \right) \text{in}$$

$$M_n = 13{,}586.1595 \text{ k.in}$$ (4)

$$\phi M_n = 0.9 \times (13{,}586.1595) = 12{,}227.5436 \text{ k.in}$$ (5).

$$\therefore M_u = \phi M_n = 12{,}227.5436 \text{ k.in} \times \frac{1 \text{ ft}}{12 \text{ in}}$$

$$M_u = 1018.96 \text{ k.fT}$$ (6)

Q7) Total factored design load, w_u :-

$$M_u = \frac{w_u l^2}{8} = \frac{w_u l_A^2}{8}$$

$$1018.96 \text{ K·ft} = \frac{w_u \times 48^2 \text{ ft}^2}{8}$$

$$\therefore \boxed{w_u = 3.538 \text{ K/FT}}$$

Q8) The self weight of concrete slab :-

$$D_{L\,SLAB} = \text{Density} \times \text{slab thickness}$$

$$= 150 \frac{lb}{ft^3} \times 5 \text{ in} \times \frac{1 ft}{12 \text{ in}}$$

$$= 62.5 \text{ lb/ft}^2$$

Q9) The total (steel + concrete) unfactored dead load on the beam, w_{DL} :-

from table 1.1, (W 16×77) $w_{DL,\,STEEL} = 77$ lb/ft

$$w_{DL} = w_{DL\text{ concrete slab}} + w_{DL\text{ steel}}$$

$$= DL_{slab} \times L_B + w_{DL,\,steel}$$

$$= 62.5 \frac{lb}{ft^2} \times 13 ft + 77 \text{ lb/ft}$$

$$w_{DL} = 889.5 \frac{lb}{ft} \times \frac{1\,K}{1000\,lb}$$

$$\therefore \boxed{w_{DL} = 0.8895\ K/ft}$$

Q10) The actual, unfactored beam live load (capacity), W_{LL} :-

$$W_U^* = 1.2\,w_{DL} + 1.6\,w_{LL}$$

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

$$W_{LL} = \frac{3.538 - 1.2\,(0.8895)}{1.6}$$

$$W_{LL} = 1.544\ K/ft$$

Q11) The actual floor live load (floor capacity), LL :-

$$LL = \frac{W_{LL}}{L_B}$$

$$LL = 1.544 \frac{K}{ft} \times \frac{1000\,lb}{1\,K} \times \frac{1}{13\,ft}$$

$$\therefore LL = 118.77\ lb/ft^2$$

Structures II
Arch 324

Name 1 ____________________
Name 2 ____________________
Name 3 ____________________

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.

Due

During recitation

Thankyou !!!