ARCH 324
STRUCTURE II

FACULTY: Prof. Peter Von Bulow

GSI: Faezeh Choobkar

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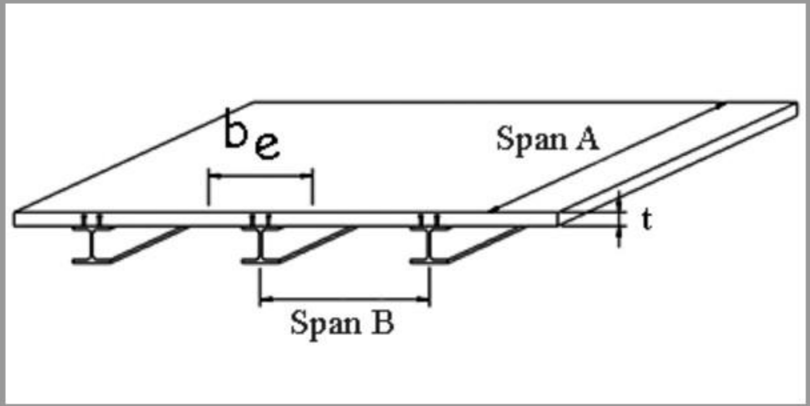
Recitation

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

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

effective width

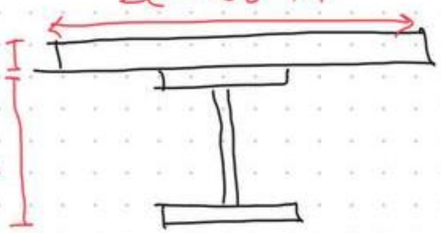
$$\min \begin{cases} \frac{1}{4}(\text{Span of steel beam}) = \frac{1}{4}(49 \times 12) = 147 \\ b_f + 2(8 \times \text{slab thickness}) = 10 + 2(8 \times 6) = \underline{\underline{106}} \checkmark \\ b_f + 2(\frac{1}{2}\text{ clear } \underline{\underline{\text{distance}}}) = 10 + 2(\frac{1}{2}(11 \times 12)) = 142 \end{cases}$$

Span B

W16X77 $\xrightarrow[\text{Table}]{\text{Based on}}$ d: 16.1 in bf: 10 in

A: 22.6 in^2 w: 77 lb/ft

effective edpth of Concrete Stress block (a)



$$a = \frac{A_s f_y}{0.85 f'_c b_e}$$

$$= \frac{22.6(50)}{0.85(3)(106)} = \frac{1130}{270.3} = 4,1805 < 6 \text{ in}$$

Assumption is True ✓ within Slab

a is within Concrete → The full Steel Section is in tension

Nominal bending Moment = Plastic Moment

$$M_n = M_p = A_s f_y \left(\frac{d}{2} + t - \frac{a}{2}\right) = 22,6(50)\left(\frac{16,7}{2} + 6 - \frac{4,1805}{2}\right)$$

$$= 13514,18 \text{ k-in}$$

$\phi M_n = 0.9(13514,8) = 12163,32$

$M_u \leq \phi M_n \rightarrow M_u = \phi M_n = 12163,32 \times \frac{1}{12} = 1013,67$ k-ft

↓

ultimate Moment that Section withstand

$M_u = \frac{w_u \ell^2}{8} \rightarrow w_u = \frac{8 M_u}{\ell^2} = \frac{8(1013,67)}{(49)^2} = 3,377$ kLf

Span A

Self weight of concrete slab

1 ft^2 150 lb

$\frac{6}{12}$ $\frac{6}{12} \times 150 = 75$

Total unfactored dead load:

Self weight (Concrete + Steel)

$(11)\,75 + 77 = 902$ plf $\xrightarrow{\div 1000}$ 0.902 klf

↓

Span B

Actual unfactored live load

$w_u = 1.2\,w_{DL} + 1.6\,w_{LL}$

$3{,}377 = 1.2\,(0.902) + 1.6\,w_{LL} \rightarrow w_{LL} = 1{,}434$ klf

Actual floor live load

$$\frac{w_{LL}}{Span} = \frac{1{,}434}{18} = 0.079673 \text{ ksf} \times 1000 = 79{,}67 \text{ PSf}$$

- Thanks for your attention ☺