TAUBMAN COLLEGE
ARCHITECTURE & URBAN PLANNING
UNIVERSITY OF MICHIGAN

Arch324
STRUCTURES II

Winter 2025
Recitation

FACULTY: Prof. Peter von Bülow
Mohsen Vatandoost

Arch324: STRUCTURES II

Welcome to Recitation session 04/11

Mohsen Vatandoost {Ph.D., M.Sc., M. Arch}

mohsenv@umich.edu

Office: Room 3122

hours:

Fri: 11:30 – 12:30

Mon, Wed: 11:00 - 12:00

walk-ins welcome!

Click here to make an appointment

Please feel free to ask questions.

Welcome to Recitation session 04/11

Outline:

- Quick **Recap** of the week
- Provide the solution for the assignment **(Homework 10)**
- Answering student's questions
- Lab: **Composite Section**
- **Tower Project:** Final report by **April 18**
- **Course Evaluation** (20+ bonus points)

Please feel free to ask questions.

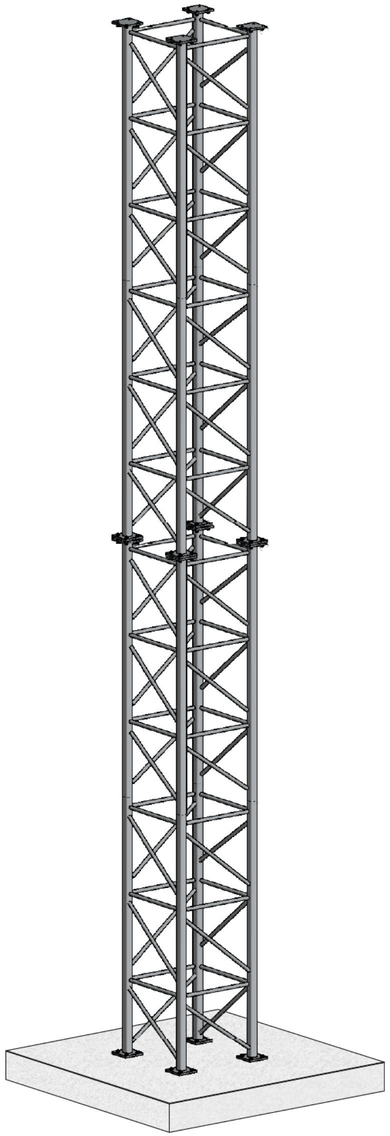
Contact: Mohsenv@umich.edu

Tower Project:

Tower Project final report:

April, 18

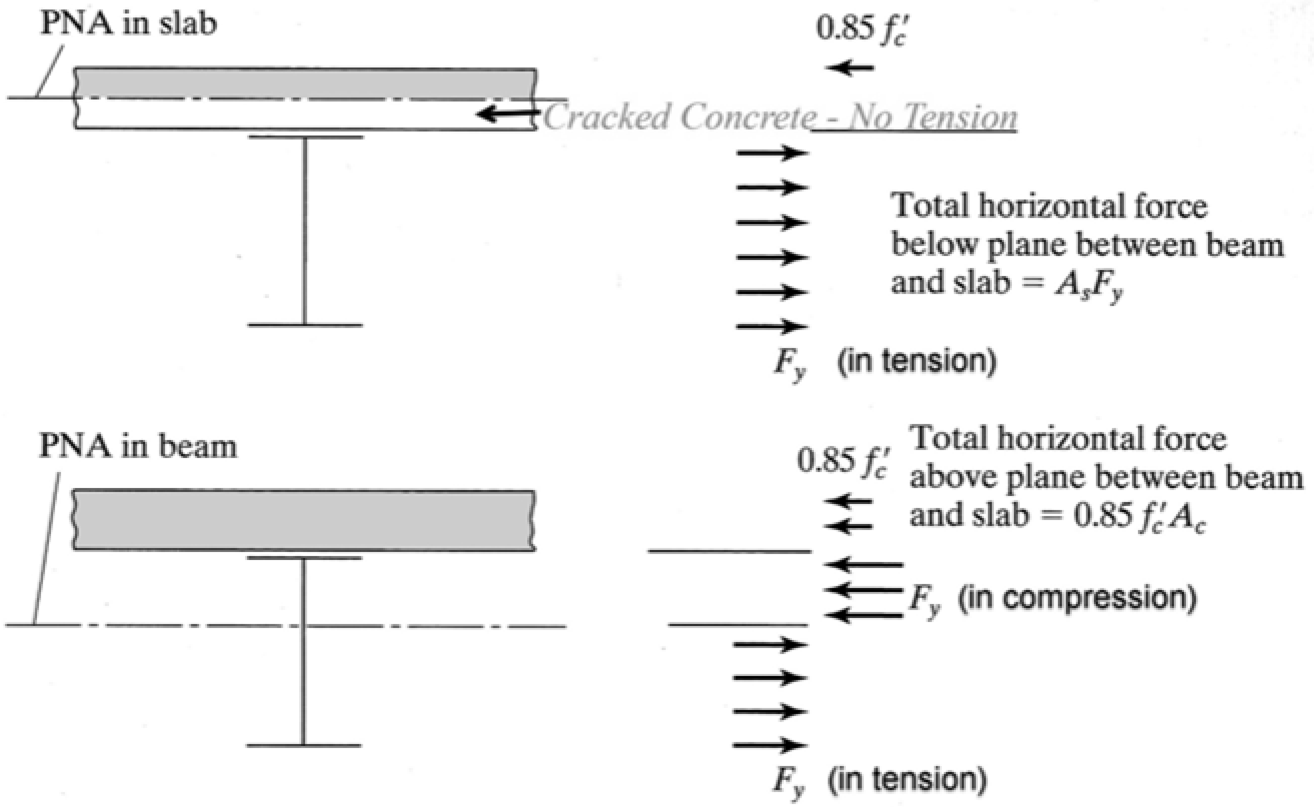
PRELIMINARY REPORT (re-submit with final report)	**40**	
TESTING	**60**	
Tower weight ≤ 4oz (15 pts); height = 48” (5 pts); holds ≥ 50 lbs (5 pts) Correct Materials (5 pts) (scaled if doesn’t meet requirements)	30	
Efficiency (4/weight OZ)+(load LBS/50)+(load LBS/weight OZ)x1.5 (scaled based on class rank)	30	
FINAL REPORT REQUIREMENTS	**150**	



Recap of the week

Analysis Procedure (LRFD)

Case 1 – Plastic Neutral Axis (PNA) within slab
Case 2 – PNA within steel section



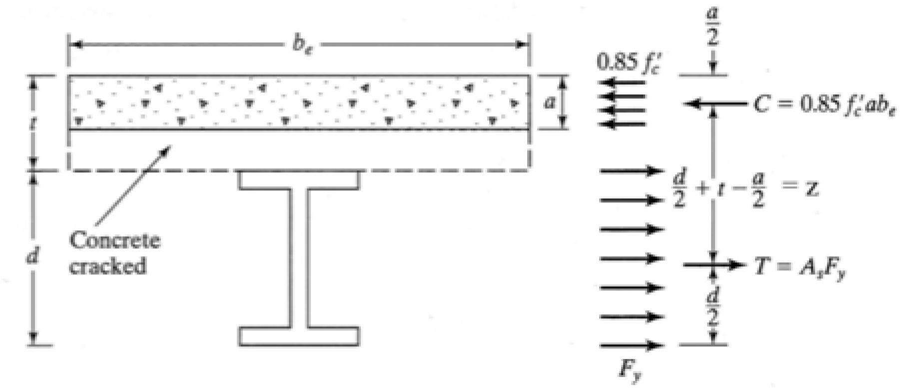
Recap of the week

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

$$T = C$$

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

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

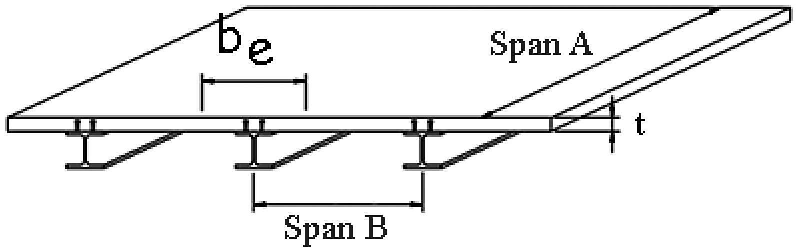
Provide the solution for the assignment – **HW10**

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.

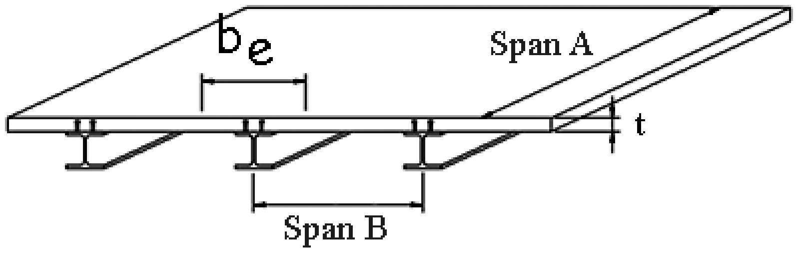
DATASET: 1 -2- -3-

W-section	W21X166
span A	70 FT
span B	18 FT
slab thickness, t	9 IN
steel yield stress, Fy	50 KSI
concrete ultimate stress, f'c	5 KSI

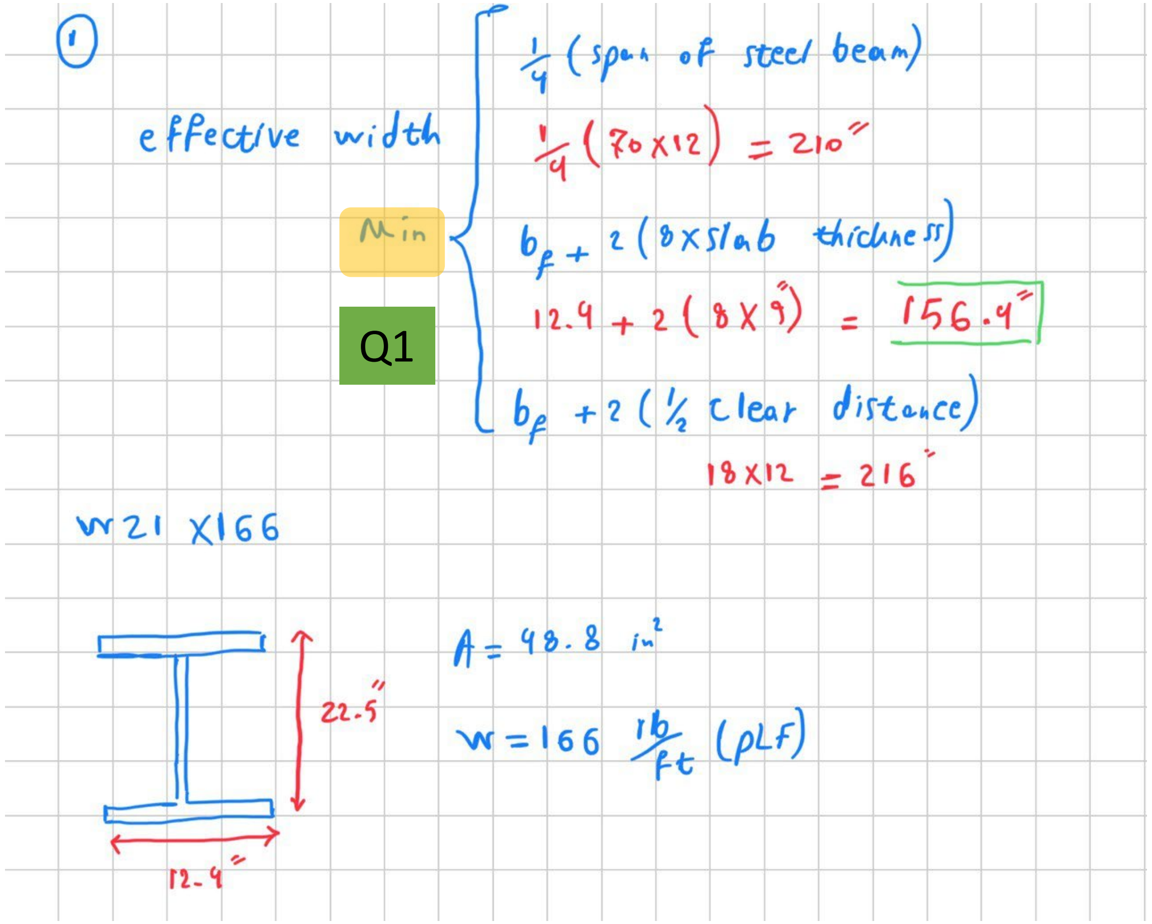


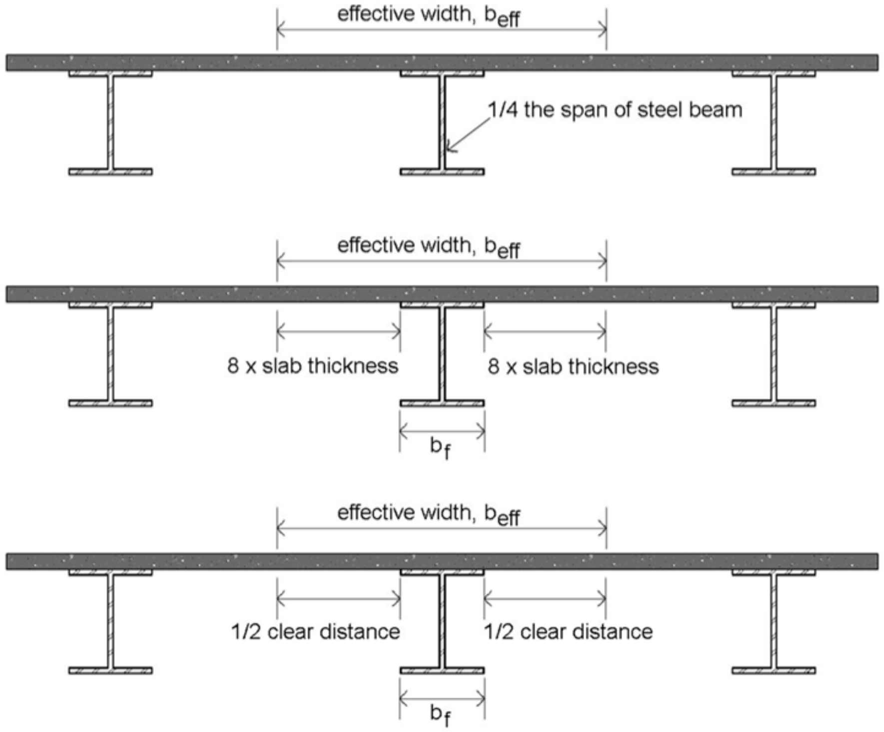
Provide the solution for the assignment – **HW10**

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



Provide the solution for the assignment – **HW10**





Provide the solution for the assignment – **HW10**

(2) effective depth of concrete stress block, a

$$a = \frac{A_s F_y}{0.85 f'_c b_e} = \frac{(48.8)(50^{ksi})}{0.85(5)(156.4)} = 3.6708'' < 9''$$

within slab

(3)

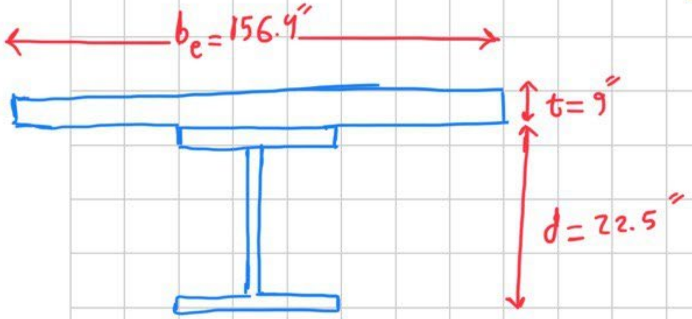
(4) If a is within Conc. Slab, the full steel section is in tension:

nominal bending moment:

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

t → slab thickness; a → Concrete stress block

$$= (48.8)(50)\left(\frac{22.5}{2} + 9 - \frac{3.6708}{2}\right) = 44931.62 \text{ k-in}$$



Q2

Q3

Provide the solution for the assignment – **HW10**

(5) $\phi M_n = 0.9(44931.62) = 40438.45$ k-in

Q5

(6) $M_u \leq \phi M_n \rightarrow M_u = \phi M_n$

$40438.45 \times \frac{1}{12} = 3369.87$ k-ft

Q6

(7) $M_u = \frac{w_u L^2}{8} \rightarrow w_u = \frac{8 M_u}{L^2} = \frac{8(3369.87 \text{ k-ft})}{(70)^2} = 5.5018$ klf

L: span A

Q7

(8) Self-weight of concrete slab:

1 ft^3 — 150 lb

$\frac{9}{12}$ — ?

$\rightarrow \frac{9}{12} \times 150 = 112.5$ psf

Q8

Provide the solution for the assignment – **HW10**

⑨ Total unfactored dead load:

Self weight (Concrete + steel)

$18(112.5) + 166 = 2191 \text{ pLF}$

$= 2.191 \text{ KLF}$

Tributary area width (→ 18)

Q9

⑩ Actual unfactored live load, w_{LL}

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

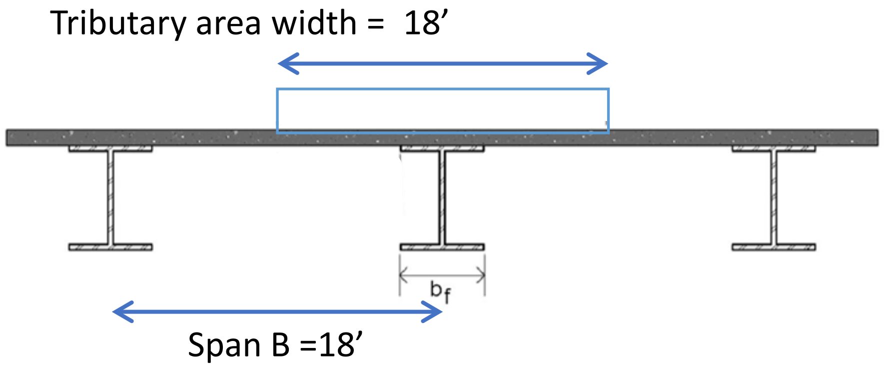
$5.5018_{\text{KLF}} = 1.2(2.191) + 1.6(w_{LL}) \longrightarrow w_{LL} = 1.7953 \text{ KLF}$

Q10

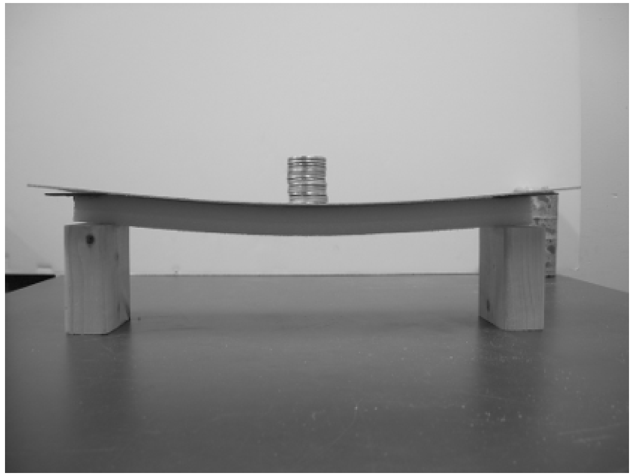
⑪ Actual floor live load:

$\dfrac{w_{LL}}{\text{Span}} = \dfrac{1.7953 \text{ KLF}}{18} = 0.0997388 \text{ KSF} \times 1000 = 99.7388 \text{ pSF}$

Q11



Lab : Composite Sections



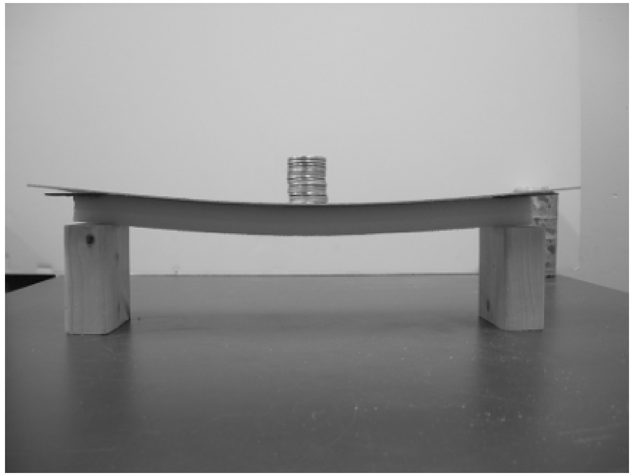
Description

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.

Lab : Composite Sections



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.

Thank you.

Any question?

Please feel free to ask questions.

Contact: Mohsenv@umich.edu