Arch 324
Structures II

Winter 2026 Recitation 004

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Recitation 004

Welcome to session 4!

- Quick Lecture Recap
- Homework #4 Steel Beam Analysis
- Tower
- Lab: None

Feel free to ask questions anytime

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Lecture: Properties of Steel

Architecture 324

Structures II

Steel Beam Analysis

- Steel Codes: ASD vs. LRFD
- Analysis Methods

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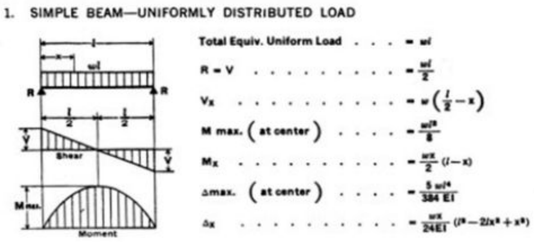
Lecture: Steel Beam Analysis

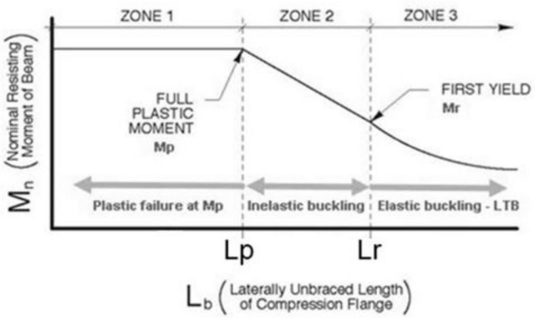
Procedure - Analysis of Steel Beams – **for Zone 1** $L_b < L_p$

Pass/Fail

Given: yield stress, steel section, loading, bracing (L_b)
Find: pass/fail of section

1. Calculate the factored design load w_u
   $w_u = 1.2w_{DL} + 1.6w_{LL}$
2. Determine the design moment M_u.
   M_u will be the maximum beam moment using the factored loads
3. Insure that $L_b < L_p$ (zone 1)
   $L_p = 1.76\, r_y \sqrt{E/Fy}$
4. Determine the nominal moment, Mn
   $M_n = F_y Z_x$ (look up Z_x for section)
5. Factor the nominal moment
   $øM_n = 0.90\, M_n$
6. Check that $M_u < øM_n$
7. Check shear
8. Check deflection





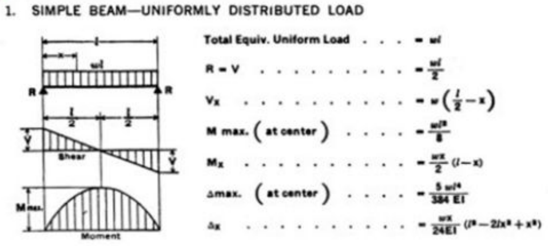
Lecture: Steel Beam Analysis

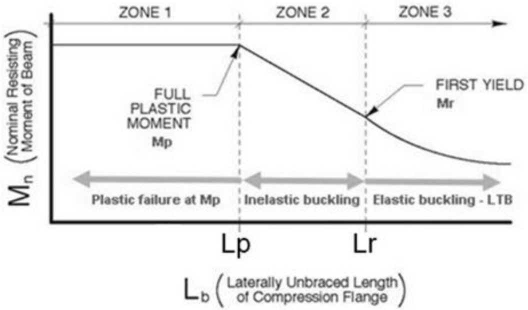
Procedure - Analysis of Steel Beam - **Capacity**

Given: yield stress, steel section, bracing

Find: moment or load capacity

1. Determine the unbraced length of the compression flange (L_b).
2. Find the L_p and L_r values from the AISC Z_x Table 3-2
3. Compare L_b to L_p and L_r and determine which equation for M_n or M_{cr} to be used.
4. Determine the beam load equation for maximum moment in the beam.
5. Calculate load based on maximum moment. $M_u = \phi_b \ M_n$



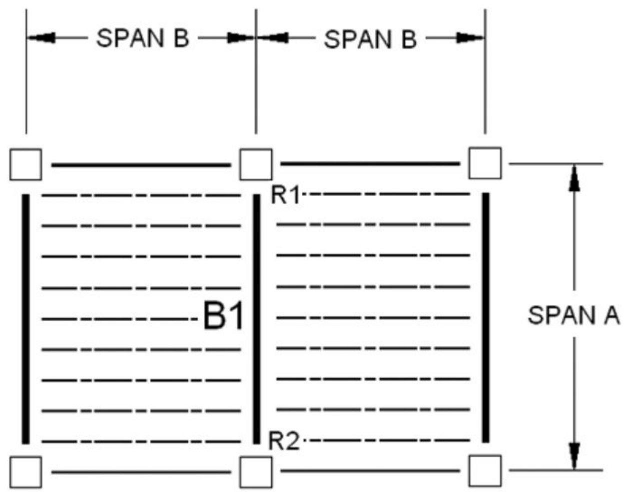


HW #4: Steel Beam Design

Analyze the given W-section for beam B1 to determine the maximum live load capacity the floor can carry. Determine the shear and bending forces and check the maximum deflection against an allowable of L/180. Assume the beam is fully braced, Lb < Lp (zone 1).

DATASET: 1 -2- -3-

W-section	W10X30
Fy	50 KSI
Span A	18 FT
Span B	12 FT
Floor DL	14 PSF



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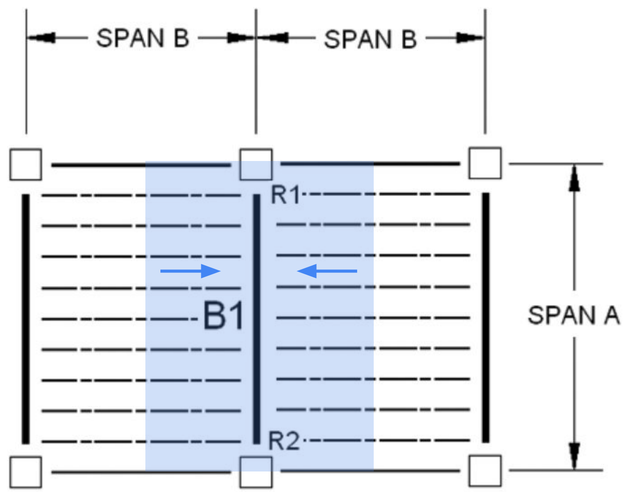

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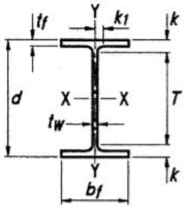


Table 1-1 (continued)
W-Shapes
Dimensions

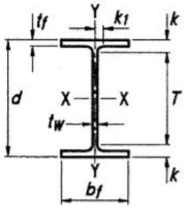
Shape	Area, A	Depth, d		Web Thickness, t_w		$\frac{t_w}{2}$	Flange Width, b_f		Flange Thickness, t_f		Distance k k_{des}	k k_{det}	k_1	T	Workable Gage
	in.^{2}	in.		in.		in.	in.		in.		in.	in.	in.	in.	in.
W10×30	8.84	10.5	10 1/2	0.300	5/16	3/16	5.81	5 3/4	0.510	1/2	0.810	1 1/8	11/16	8 1/4	2 3/4 g
×26	7.61	10.3	10 3/8	0.260	1/4	1/8	5.77	5 3/4	0.440	7/16	0.740	1 1/16	11/16	↓	↓
×22c	6.49	10.2	10 1/8	0.240	1/4	1/8	5.75	5 3/4	0.360	3/8	0.660	15/16	5/8		

Table 1-1 (continued)
W-Shapes
Properties

W12-W10

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}
30	5.70	29.5	170	32.4	4.38	36.6	16.7	5.75	1.37	8.84	1.60	10.0	0.622	414
26	6.56	34.0	144	27.9	4.35	31.3	14.1	4.89	1.36	7.50	1.58	9.86	0.402	345
22	7.99	36.9	118	23.2	4.27	26.0	11.4	3.97	1.33	6.10	1.55	9.84	0.239	275

HW #4: Steel Beam Design



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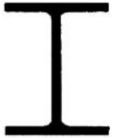

W12-W10

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lb/ft			in.^{4}	in.^{3}	in.	in.^{3}	in.^{4}	in.^{3}	in.	in.^{3}	in.	in.	in.^{4}	in.^{6}
30	5.70	29.5	170	32.4	4.38	36.6	16.7	5.75	1.37	8.84	1.60	10.0	0.622	414
26	6.56	34.0	144	27.9	4.35	31.3	14.1	4.89	1.36	7.50	1.58	9.86	0.402	345
22	7.99	36.9	118	23.2	4.27	26.0	11.4	3.97	1.33	6.10	1.55	9.84	0.239	275

Q1

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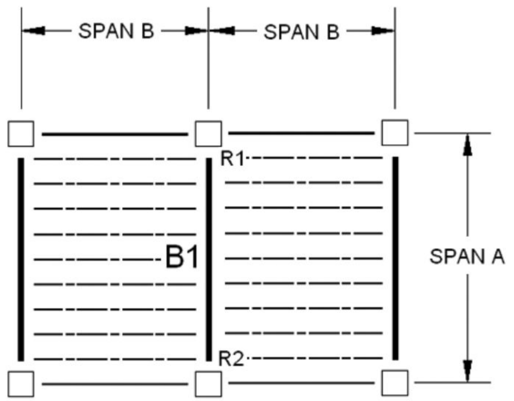

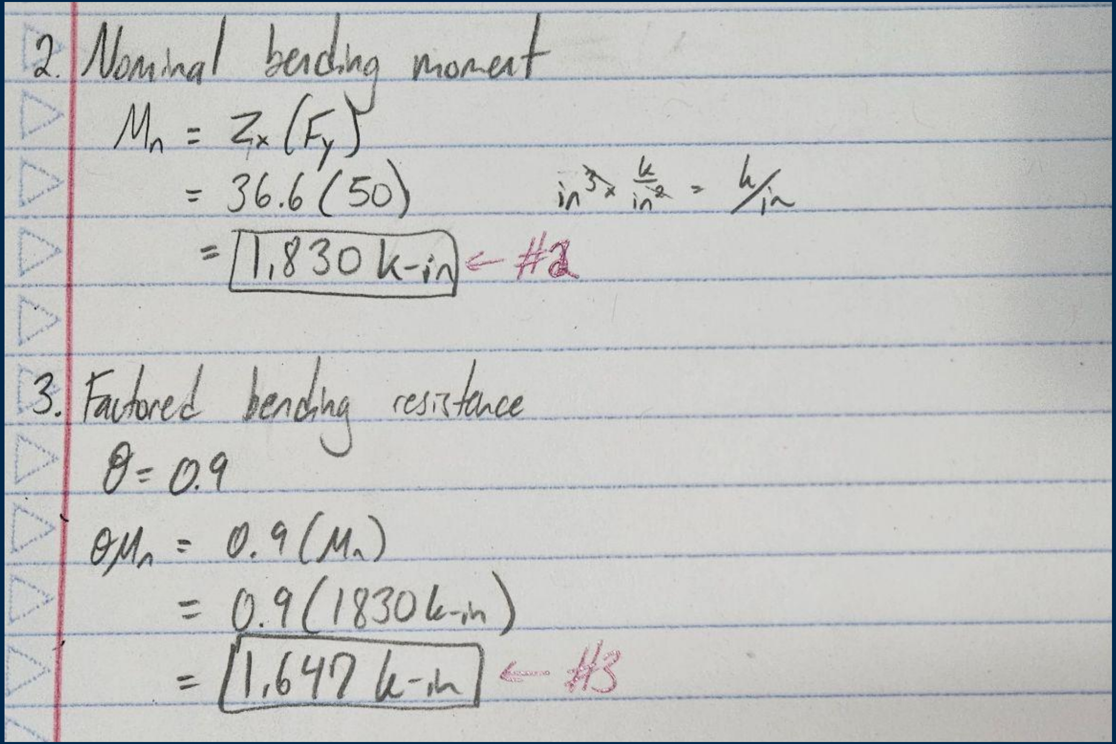

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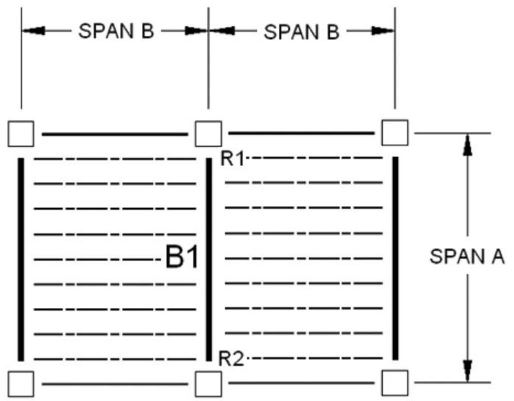

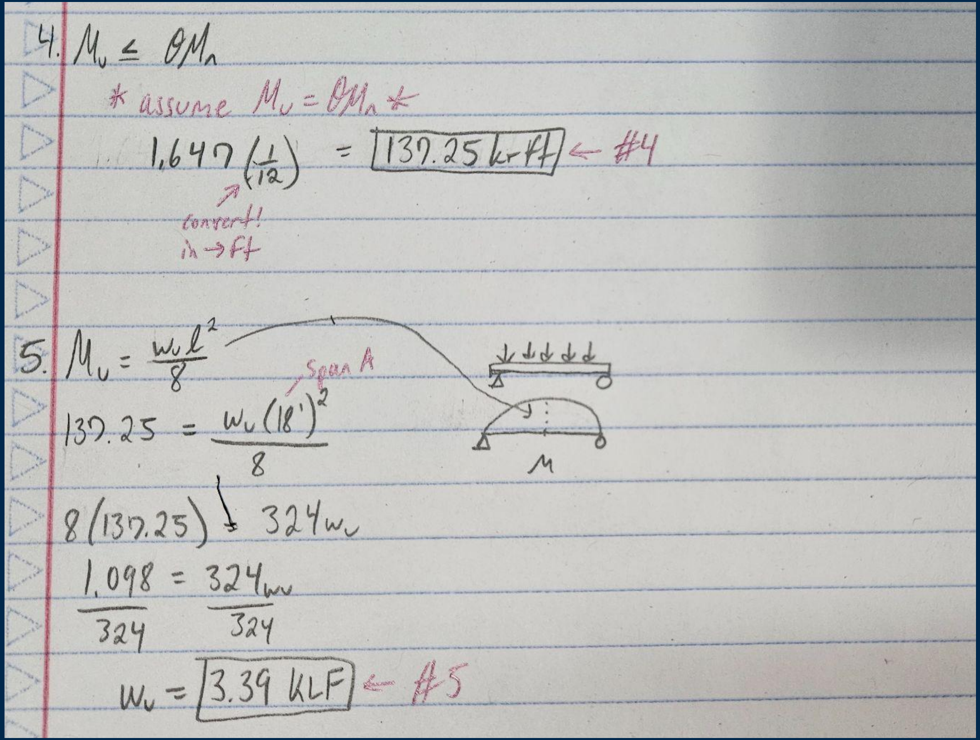

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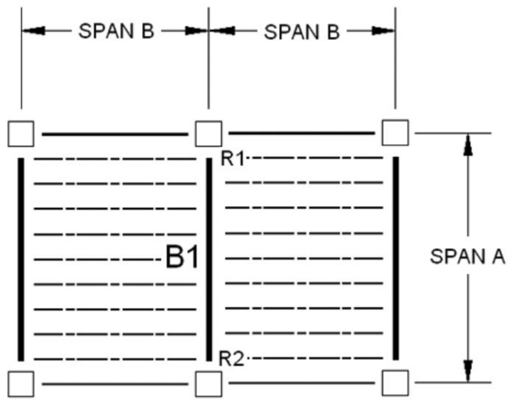

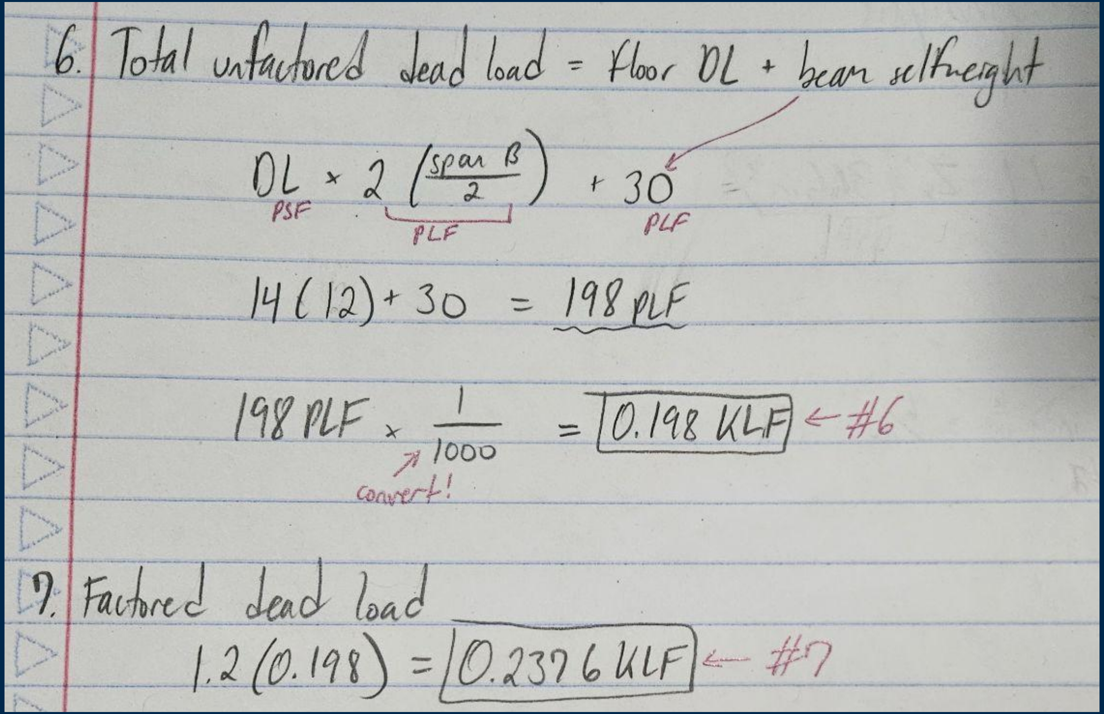

6. Total unfactored dead load = floor DL + beam selfweight

$DL \times 2\left(\frac{\text{span B}}{2}\right) + 30$ (PSF, PLF, PLF)

$14(12) + 30 = 198$ PLF

$198 \text{ PLF} \times \frac{1}{1000} = 0.198$ KLF ← #6 (convert!)

7. Factored dead load

$1.2(0.198) = 0.2376$ KLF ← #7

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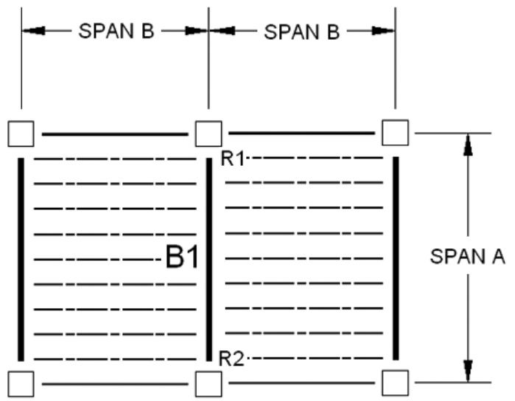

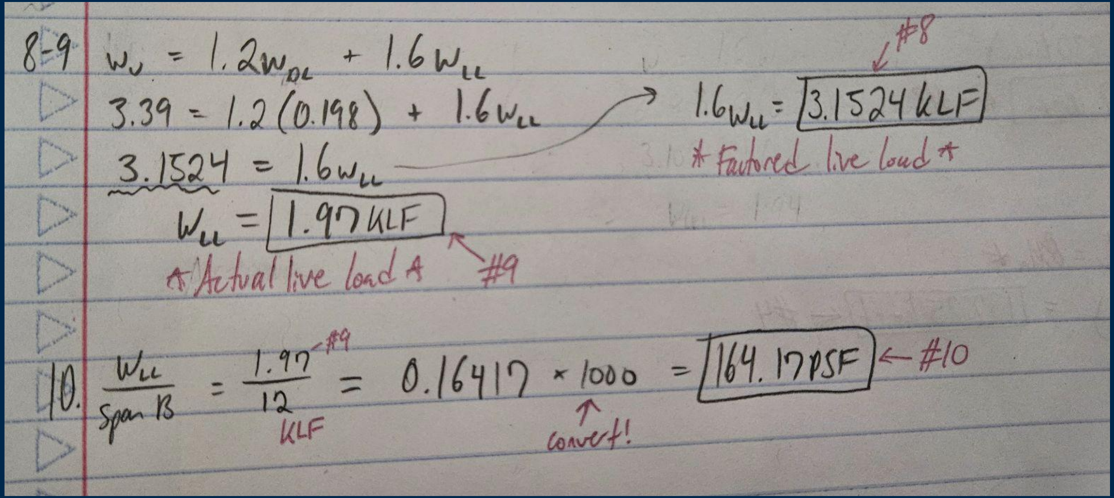

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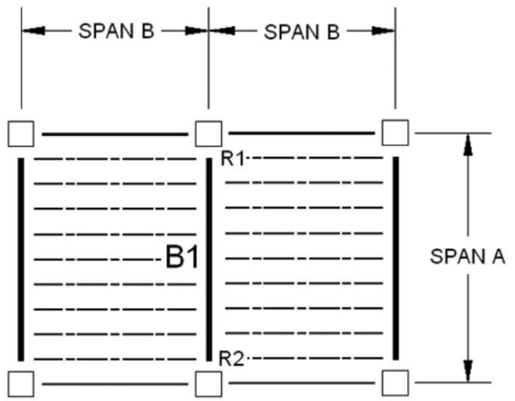

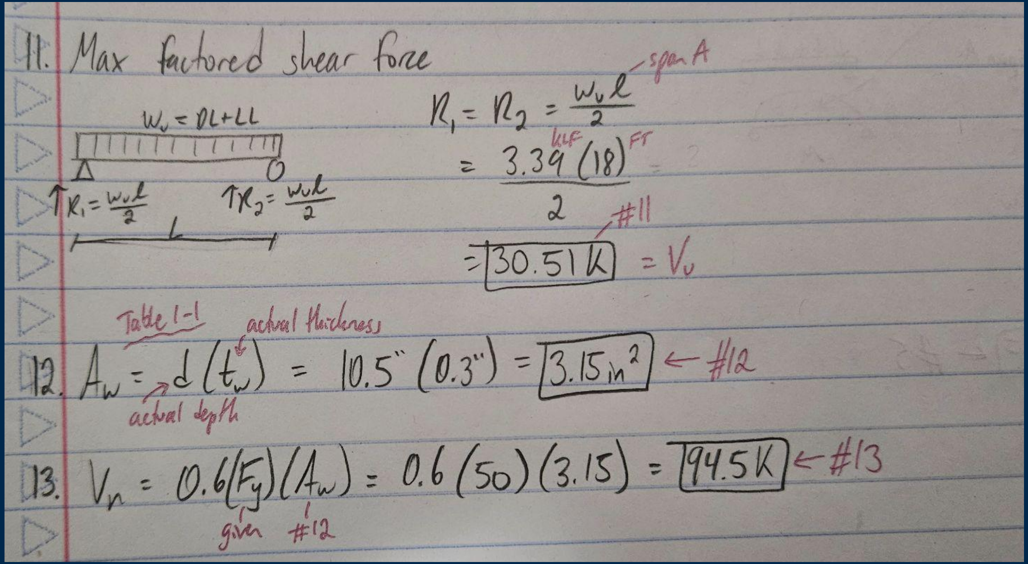

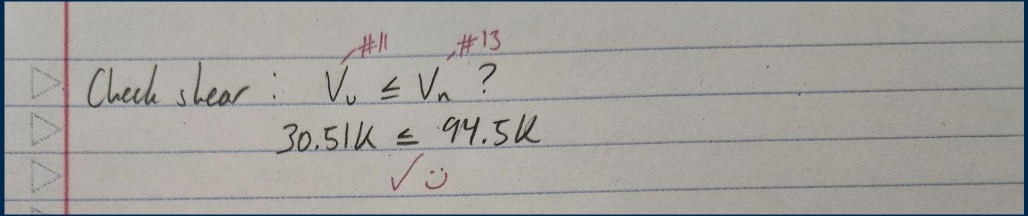

Q14

Section safe for shear = 1

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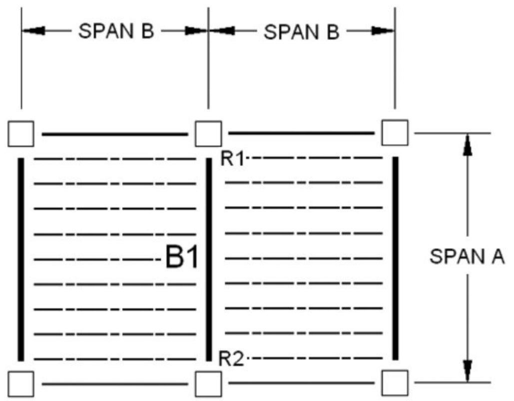

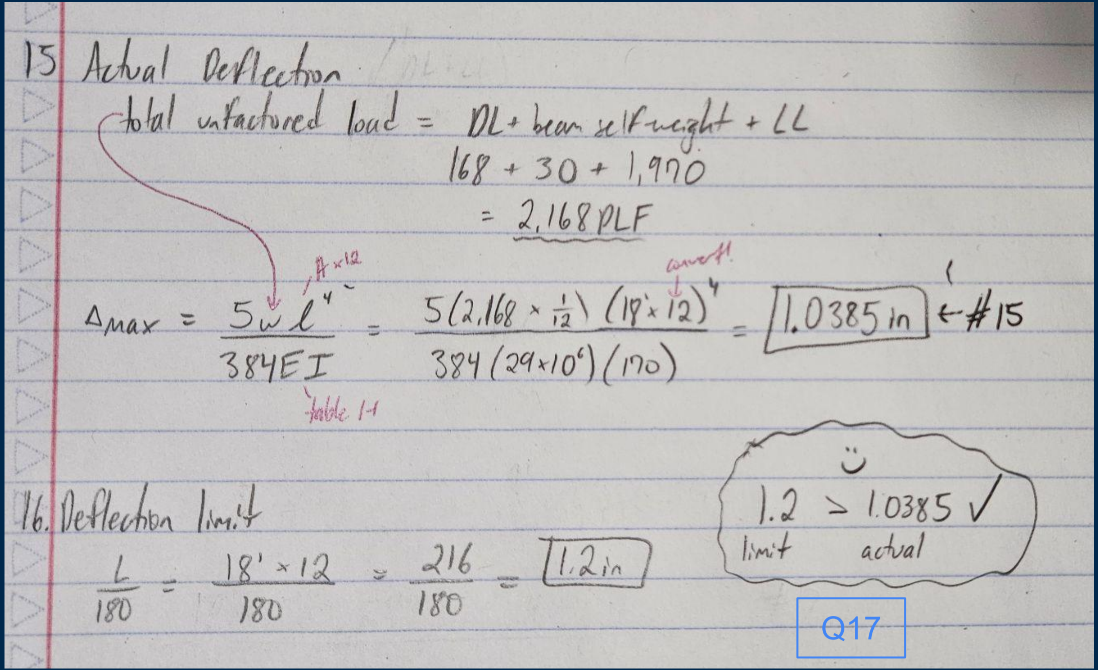

15 Actual Deflection

total unfactored load = DL + beam selfweight + LL

168 + 30 + 1,970

= 2,168 PLF

$$\Delta_{max} = \frac{5wl^4}{384EI} = \frac{5(2{,}168 \times \frac{1}{12})(18' \times 12)^4}{384(29 \times 10^6)(170)} = \boxed{1.0385 \text{ in}} \leftarrow \#15$$

(ft ×12; convert!; table 1-1)

16. Deflection limit

$$\frac{L}{180} = \frac{18' \times 12}{180} = \frac{216}{180} = \boxed{1.2 \text{ in}}$$

1.2 > 1.0385 ✓ (limit, actual)

Q17

Section safe for deflection = 1

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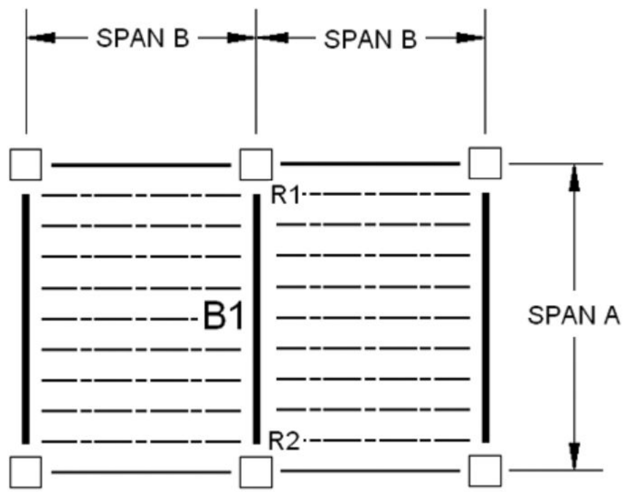

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Tower

Due Dates:

- **Preliminary Report - 2.13 (next Friday!!)**
- Bridge Testing - 03.23 (Monday)
- Final Report - 04.17 (Sunday)

Scoring:

- See rubric linked on website for more specifics
- 40 points = prelim report
- 60 points = performance
  - Meet requirements = 30pts
  - Efficiency = 30pts
- 150 points = final report
- 250 pts total!

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Tower

Key Rules:

- Wood + glue only!
- Max cross-section = ¼" even when laminating multiple pieces together
- Height of tower = 48"
- Weight no more than 4oz
- Must hold at least 50lbs
- Load on top of the tower*

*You are allowed to use a loose piece of MDF or plywood as a tray to stack weights (wont count toward total weight/load)

Tower

How to Start:

- Get with your group!!
- Review examples
- Consider wood
    - Type will affect strength→weight ratio
- Get working on prelim asap!! :O

No lab today - have a great weekend :)

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