Arch324

STRUCTURES II

Winter 2024
Recitation

FACULTY: Prof. Peter von Bülow

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Arch324: STRUCTURES II

Welcome to Recitation session 02/23

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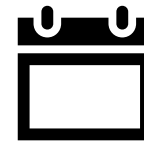
mohsenv@umich.edu

Office: Room 3104
hours:
Fri: 11:30 – 14:30
Mon, Wed: 11:00 - 12:00
walk-ins welcome!

Click here to make an appointment

Please feel free to ask questions.

Where can you find me?

Arch324: STRUCTURES II
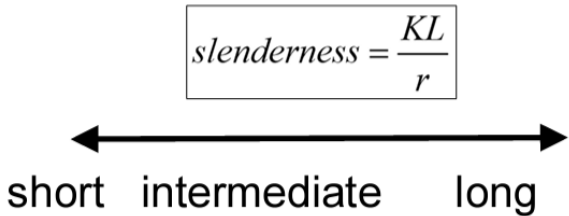
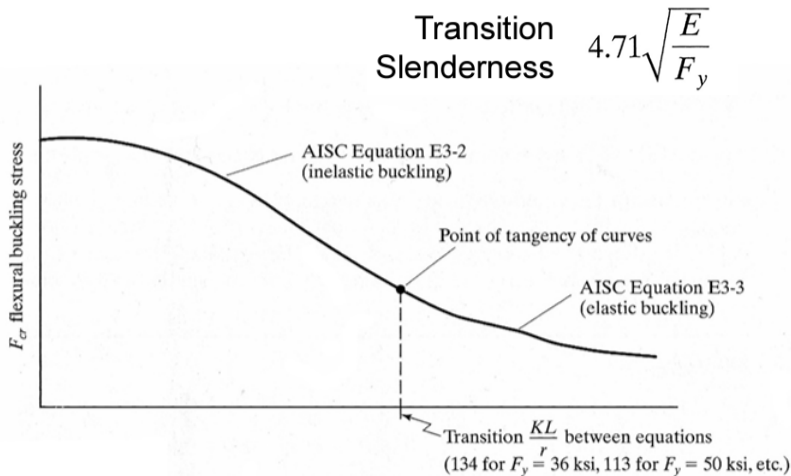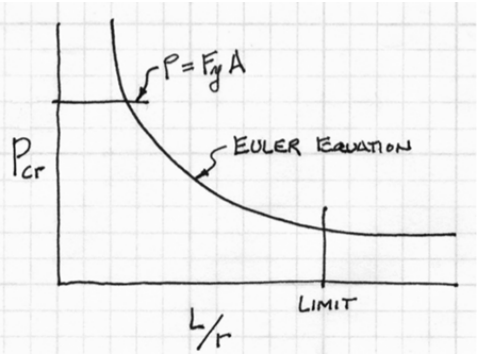# Welcome to Recitation session 02/23

Outline:

- Quick **Recap** of the week

- Provide the solution for the assignment **(Homework 6)**

- Answering student's questions

- Lab: **---**

- **Tower Project:** Preliminary report, due date: Feb 23

Please feel free to ask questions.

Steel Columns

Transition Slenderness $4.71\sqrt{\dfrac{E}{F_y}}$

F_{cr} flexural buckling stress

AISC Equation E3-2 (inelastic buckling)

Point of tangency of curves

AISC Equation E3-3 (elastic buckling)

Transition $\dfrac{KL}{r}$ between equations (134 for $F_y = 36$ ksi, 113 for $F_y = 50$ ksi, etc.)

$$slenderness = \frac{KL}{r}$$

short   intermediate   long

Euler equation:

$$F_e = \frac{\pi^2 E}{\left(\dfrac{KL}{r}\right)^2}$$

Short & Intermediate Columns:

$$F_{cr} = \left[0.658^{\frac{F_y}{F_e}} \right] F_y$$

Equation E3-2

Long Columns:

$$F_{cr} = 0.877 F_e$$

$P = F_y A$

P_{cr}

EULER EQUATION

LIMIT

L/r

TABLE C-A-7.1
Approximate Values of Effective Length Factor, K

	(a)	(b)	(c)	(d)	(e)	(f)
Buckled shape of column is shown by dashed line						
Theoretical K value	0.5	0.7	1.0	1.0	2.0	2.0
Recommended design value when ideal conditions are approximated	0.65	0.80	1.2	1.0	2.1	2.0

End condition code

Rotation fixed and translation fixed

Rotation free and translation fixed

Rotation fixed and translation free

Rotation free and translation free

Provide the solution for the assignment – **HW6**

- ## Problem:

6. Steel Column Analysis

For the given axially loaded steel W-section, determine the maximum floor live load capacity, P LL. Assume the column is pinned top and bottom: K = 1.0, and there is no intermediate bracing. Use AISC-LRFD steel equations to determine phi Pn and the load. E = 29000 ksi.
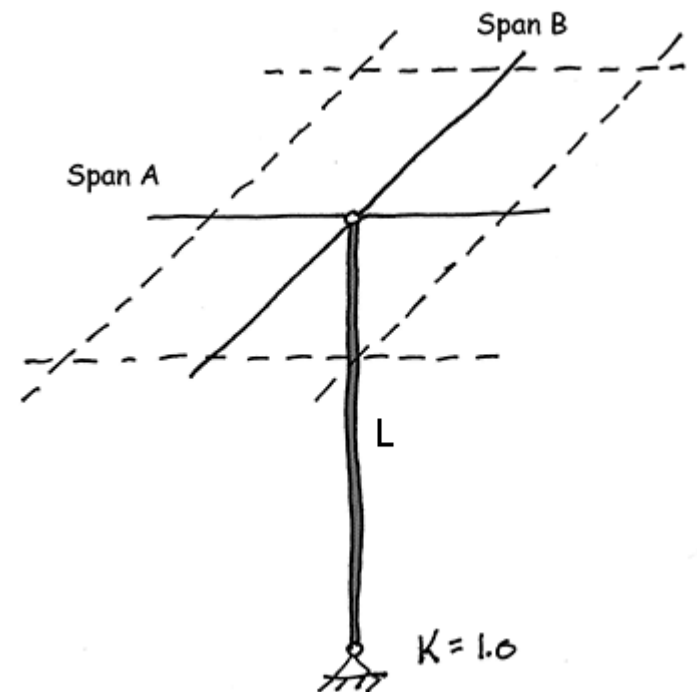
DATASET: 1	-2-	-3-
W-section		W8X35
Fy		50 KSI
Span A		34 FT
Span B		46 FT
Height L		17 FT
Floor Dead Load		18 PSF

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Provide the solution for the assignment – HW6

Span B

Span A

L

K = 1.0
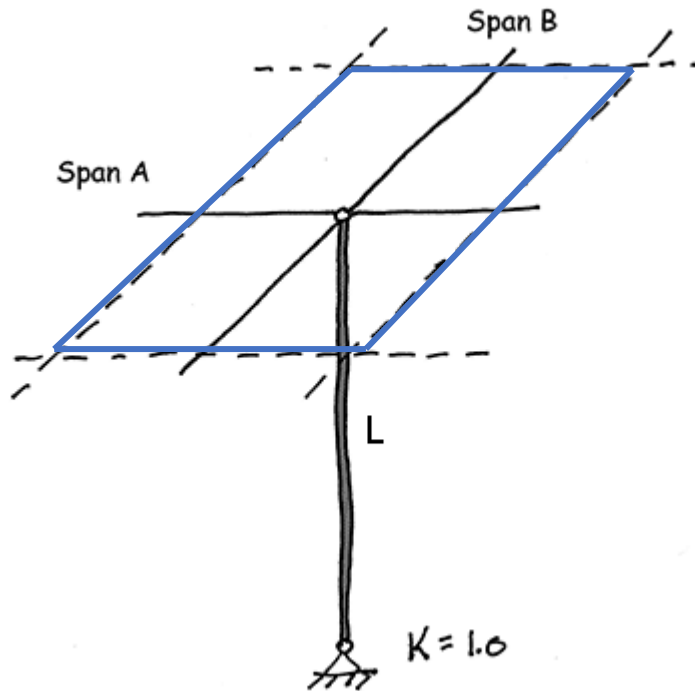
#	Question	Your Response	
1	Total unfactored floor dead load on the column		KIPS
2	Controlling slenderness ratio		
3	Transition slenderness value, 4.71(E/Fy)^.5		
4	Euler stress, Fe		KSI
5	Critical stress, Fcr		KSI
6	Nominal strength, Pn		KIPS
7	Factored nominal strength, phi Pn		KIPS
8	UN-factored live load on column (actual total LL)		KIPS
9	Actual unfactored floor live load		PSF

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Provide the solution for the assignment – HW6

Tributary Area: Span A x Span B = 34 x 46 = 1564 ft²

Dead load: 18 PSF

Total floor dead load: $18 \times 1564 = 28152 \times \dfrac{lb}{1000} = 28.152$ Kips

□ Slenderness ratio: $\lambda = \dfrac{KL}{r}$

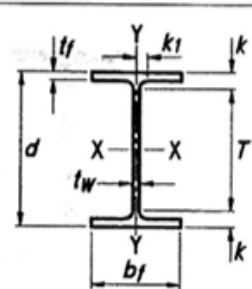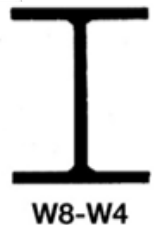W 8x35 ⟶ Table 1-1a

$r_u = 3.51''$

$r_y = 2.03''$

$A_g = 10.3$ in²

Table 1-1 (continued)
W-Shapes
Dimensions

Shape	Area, A in.²	Depth, d in.	Web Thickness, t_w in.	$\dfrac{t_w}{2}$ in.	Flange Width, b_f in.	Flange Thickness, t_f in.	Distance k_{des} in.	Distance k_{det} in.	k_1 in.	T in.	Work-able Gage in.
W8×67	19.7	9.00 9	0.570	9/16	5/16	8.28 8¼	0.935	15/16	1.33 1⁵⁄₈	15/16 5³⁄₄	5½
×58	17.1	8.75 8³⁄₄	0.510	½	¼	8.22 8¼	0.810	13/16	1.20 1½	7/8	
×48	14.1	8.50 8½	0.400	3/8	3/16	8.11 8⅛	0.685	11/16	1.08 1³⁄₈	13/16	
×40	11.7	8.25 8¼	0.360	3/8	3/16	8.07 8⅛	0.560	9/16	0.954 1¼	13/16	
×35	10.3	8.12 8⅛	0.310	5/16	3/16	8.02 8	0.495	½	0.889 1³⁄₁₆	13/16	
×31ᶠ	9.13	8.00 8	0.285	5/16	3/16	8.00 8	0.435	7/16	0.829 1⅛	3/4	

Table 1-1 (continued)
W-Shapes
Properties

W8–W4

Nom-inal Wt. lb/ft	Compact Section Criteria $\dfrac{b_f}{2t_f}$	Compact Section Criteria $\dfrac{h}{t_w}$	Axis X-X I in.⁴	Axis X-X S in.³	Axis X-X r in.	Axis X-X Z in.³	Axis Y-Y I in.⁴	Axis Y-Y S in.³	Axis Y-Y r in.	Axis Y-Y Z in.³	r_{ts} in.	h_o in.	Torsional Properties J in.⁴	Torsional Properties C_w in.⁶
67	4.43	11.1	272	60.4	3.72	70.1	88.6	21.4	2.12	32.7	2.43	8.07	5.05	1440
58	5.07	12.4	228	52.0	3.65	59.8	75.1	18.3	2.10	27.9	2.39	7.94	3.33	1180
48	5.92	15.9	184	43.2	3.61	49.0	60.9	15.0	2.08	22.9	2.35	7.82	1.96	931
40	7.21	17.6	146	35.5	3.53	39.8	49.1	12.2	2.04	18.5	2.31	7.69	1.12	726
35	8.10	20.5	127	31.2	3.51	34.7	42.6	10.6	2.03	16.1	2.28	7.63	0.769	619
31	9.19	22.3	110	27.5	3.47	30.4	37.1	9.27	2.02	14.1	2.26	7.57	0.536	530

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Provide the solution for the assignment – HW6

$$\lambda_u = \frac{\overset{\text{effective length factor}}{\boxed{K}L}}{r_u} = \frac{1 \times 17 \times 12 \; \text{in}}{3.51 \; \text{in}} = 58.1196 < 200$$

$$\lambda_y = \frac{KL}{r_y} = \frac{1 \times 17 \times 12}{2.03} = \underline{100.49} < 200$$

maximum is governing the design

☐ Transition slenderness value: (short or long column?)

$$4.71 \sqrt{\frac{E}{F_y}} = 4.71 \sqrt{\frac{29000 \; ksi}{50 \; ksi}} = 113.43$$

☐ Euler stress, F_e : $\dfrac{\pi^2 E}{\left(\dfrac{KL}{r}\right)^2} = \dfrac{(3.1415)^2 \; 29000 \; ksi}{(100.49)^2} = 28.3417 \; ksi$

Provide the solution for the assignment – HW6

☐ critical stress, F_{cr} :

short column:

$$F_{cr} = \left[0.658^{\frac{F_y}{F_e}} \right] F_y = \left[0.658^{\frac{50}{28.34}} \right] 50 = 23.8938 \text{ ksi}$$

$$0.4778$$

long column: $F_{cr} = 0.877 F_e$

☐ Nominal strength, P_n

$$P_n = F_{cr} \cdot A_g = 23.8938 \times 10.3 = 246.10 \text{ kips}$$
$$ \text{ksi} \quad \text{in}^2$$

$$\phi P_n = 0.9 \times 246.10 = 221.4955$$

Provide the solution for the assignment – HW6

$$P_u \leq \phi P_n$$

$$P_u = 1.2 \, \boxed{P_D} + 1.6 \, P_L \leq 221.4955 \longrightarrow P_L = 117.32 \text{ kips}$$
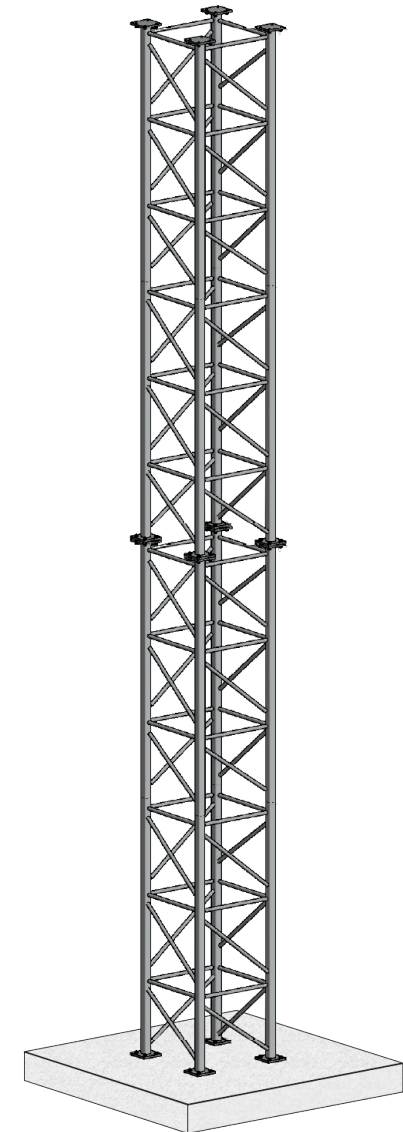
28.152

Actual unfactored floor live load:

$$\frac{P_L}{\text{Tributary Area}} = \frac{117.32 \times 1000 \text{ lb}}{34 \times 46 \text{ in}^2} = 75.012 \text{ psf}$$

Tower Project: How to start

Due date for the Preliminary report is Feb 23
Tower Test : March 20

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Thank you.
Enjoy your break!
Any question?

Please feel free to ask questions.

Contact: Mohsenv@umich.edu

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