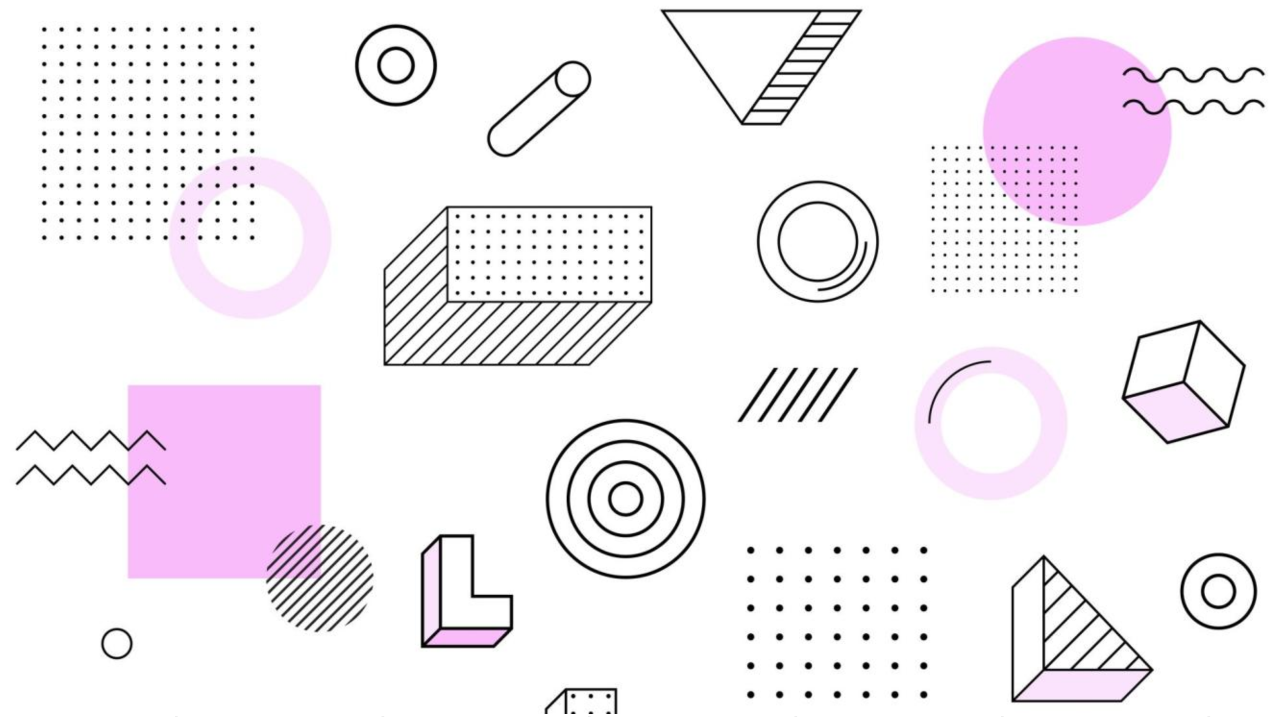
ARCH 324
STRUCTURE II



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Winter 2025

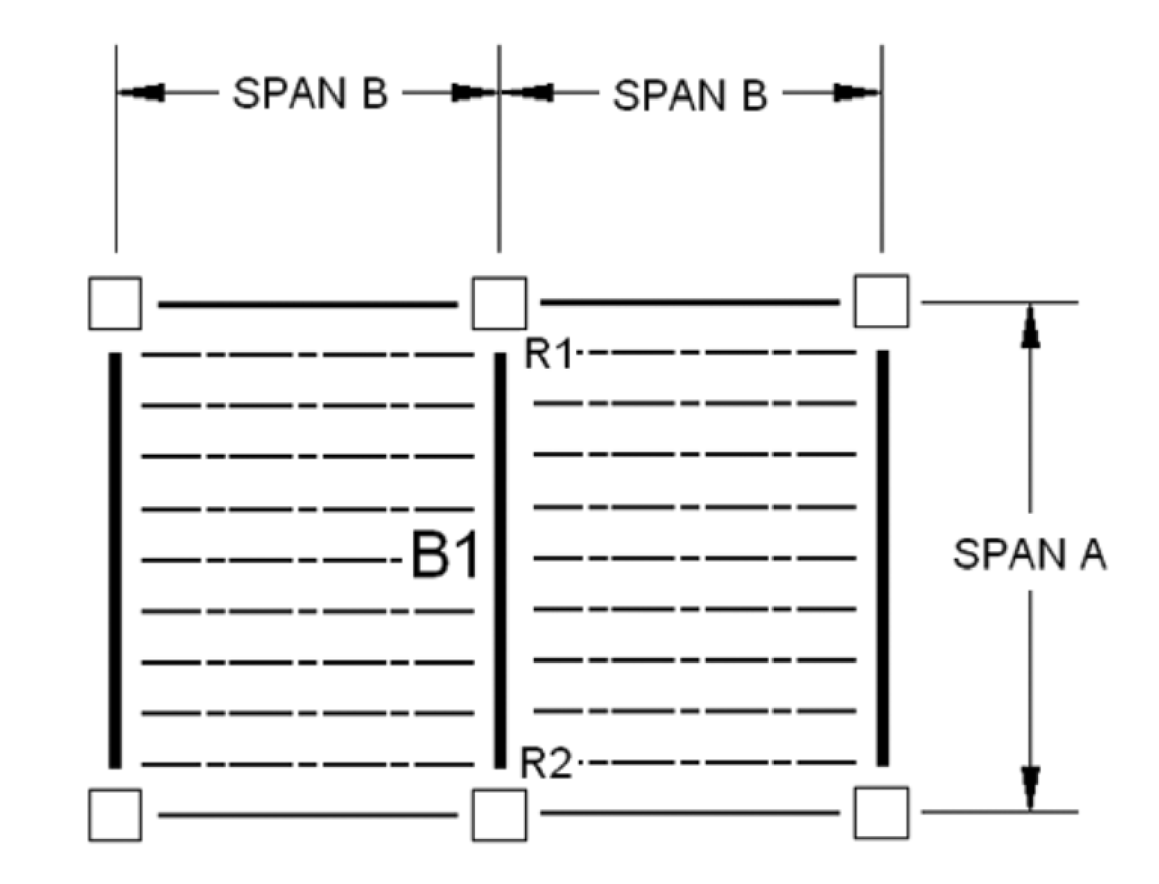
Recitation

4. Steel Beam Analysis

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



Maximum live load capacity?
BASED ON LRFD

Determine shear force
Determine bending force
Check maximum deflection against allowable L/180
Beam is fully braced : $L_b < L_p$ → ZONE 1

W section: w10*30
Fy=50 KSI
Span A = 18 FT
Span B = 12 FT
Floor DL = 14 PSF

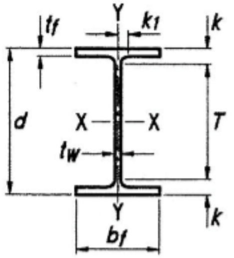


Table 1-1 (continued)
W-Shapes
Dimensions

Shape	Area, A	Depth, d		Web Thickness, t_w		$t_w/2$	Flange Width, b_f		Flange Thickness, t_f		Distance k k_{des}	k_{det}	k_1	T	Work-able 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	↓	↓
×22[c]	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	↓	↓
W10×19	5.62	10.2	10 1/4	0.250	1/4	1/8	4.02	4	0.395	3/8	0.695	15/16	5/8	8 3/8	2 1/4[g]
×17[c]	4.99	10.1	10 1/8	0.240	1/4	1/8	4.01	4	0.330	5/16	0.630	7/8	9/16	↓	↓
×15[c]	4.41	9.99	10	0.230	1/4	1/8	4.00	4	0.270	1/4	0.570	13/16	9/16	↓	↓
×12[c,f]	3.54	9.87	9 7/8	0.190	3/16	1/8	3.96	4	0.210	3/16	0.510	3/4	9/16	↓	↓

[c] Shape is slender for compression with $F_y = 50$ ksi.
[f] Shape exceeds compact limit for flexure with $F_y = 50$ ksi.
[g] The actual size, combination and orientation of fastener components should be compared with the geometry of the cross section to ensure compatibility.
[v] Shape does not meet the h/t_w limit for shear in AISC *Specification* Section G2.1(a) with $F_y = 50$ ksi.

Table 1-1 (continued)
W-Shapes
Properties

W12-W10

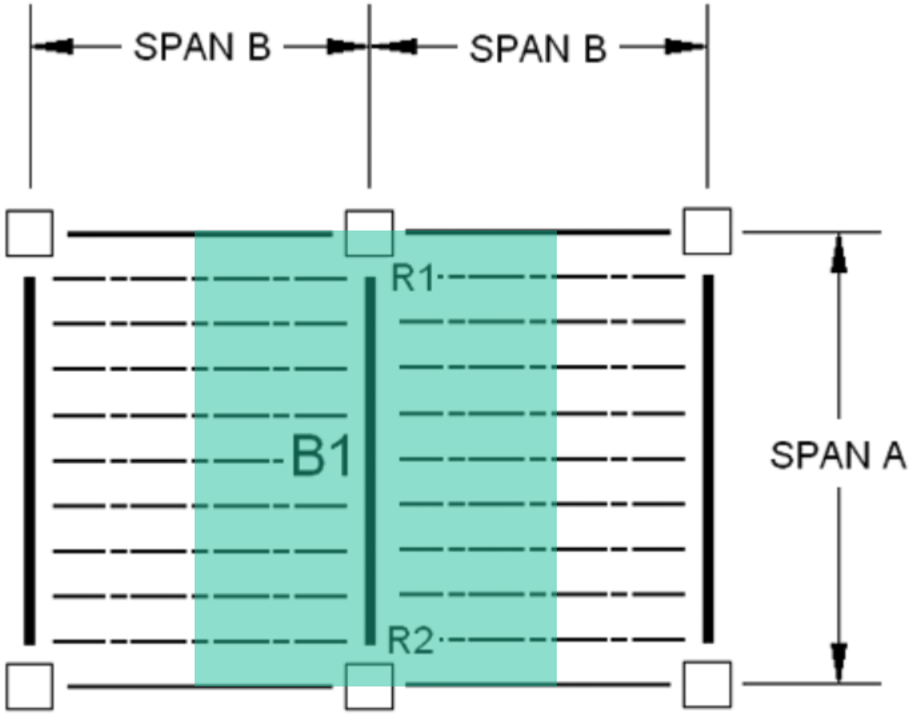
Nom-inal Wt.	Compact Section Criteria $b_f/2t_f$	h/t_w	Axis X-X I	S	r	Z	Axis Y-Y I	S	r	Z	r_{ts}	h_o	Torsional Properties J	C_w
lb/ft			in.^{4}	in.^{3}	in.	in.^{3}	in.^{4}	in.^{3}	in.	in.^{3}	in.	in.	in.^{4}	in.^{6}
30	5.70	29.5	170	32.4	4.38	36.6	16.7	5.75	1.37	8.84	1.60	10.0	0.622	414
26	6.56	34.0	144	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
19	5.09	35.4	96.3	18.8	4.14	21.6	4.29	2.14	0.874	3.35	1.06	9.81	0.233	104
17	6.08	36.9	81.9	16.2	4.05	18.7	3.56	1.78	0.845	2.80	1.04	9.77	0.156	85.1
15	7.41	38.5	68.9	13.8	3.95	16.0	2.89	1.45	0.810	2.30	1.01	9.72	0.104	68.3
12	9.43	46.6	53.8	10.9	3.90	12.6	2.18	1.10	0.785	1.74	0.983	9.66	0.0547	50.9

AISC TABLE 1-1

Calculate design load

$W_u = 1.2\ W_{DL} + 1.6\ W_{LL}$

IN LRFD WE INCREASE THE LOADS AND DECREASE NOMINAL BENDING STRENGHT



$F_y = 50$ ksi Table 1-1: $Z_{x-x} = 36.6$ in^3

W10X30

Assume that the beam is fully braced : $L_b < L_p$

$M_n = M_p$

$M_n = Z_x \cdot F_y = (36.6)(50) = 1830$

ϕ in bending is : 0.9

$\phi \times M_n = (0.9)(1830) = 1647$ k-in

$M_u \leq \phi M_n$

Assume $M_u = \phi M_n = 1647$ k-in $= \frac{1647}{12} = 137{,}25$ k-ft

we need to find w_u ?

$$M_u = \frac{w_u \cdot \ell^2}{8}$$

$$137{,}25 = \frac{w_u \times (18)^2}{8} \rightarrow w_u = 3{,}388 \text{ klf}$$

w_u is the Combination of DL, LL & self weight total unfactored dead load = Floor DL + Beam Self weight

$$14\ Psf \times 2\left(\frac{\text{Span B}}{2}\right) + 30\ PLF$$

$\text{Span B} \rightarrow 12$

$168 + 30 = 198\ PLF \xrightarrow{\times 1/1000} 0.198$

Factored DL = 1,2 (0.198) = 0.2376

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

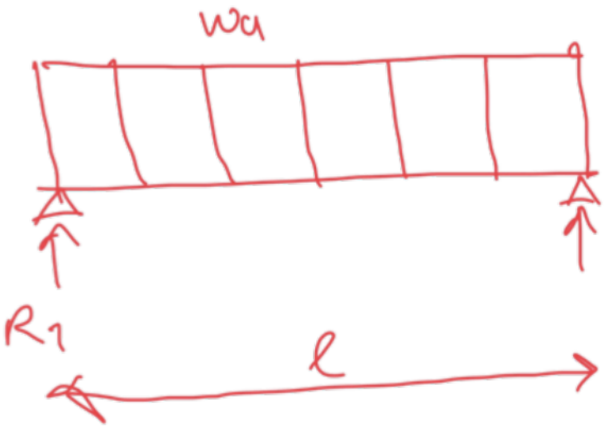
$3{,}388 = 1.2\,(0.198) + 1.6\,(w_{LL})$

$1.6(w_{LL}) = 3.15$ factored live load

$w_{LL} = 1.969$ Actual live load

$$A_w = d \cdot t_w = (10.5)(0.3) = 3.15 \text{ in}^3$$

$$V_n = 0.6 F_y A_w = 0.6(50)(3.15) = 94.5$$



Max shear: $V_u = R_1 = R_2 = \frac{3.388(18)}{2} = 30.492$

$R_2 = \frac{w_u \ell}{2}$

Check if $V_u \le V_n$?

$30.492 \le 94.5$ ✓

Defelection :

limit $L/180 = \frac{18 \times 12}{180} = 1.2$ in

Formula baced on AISC for uniform loading on the beam :

$$\Delta max = \frac{5wl^4}{384EI}$$ → table

convert to in

$$= \frac{5(2195 \times 1/12)(18 \times 12)^4}{384(29 \times 10^6)(170)} = 1,03847$$

W = total unfactored load = DL + Self weight + LL

Convert unit ← 196 + 30 + 1969 = 2195

$\Delta max <$ Limit ✓

- Thanks for your attention ☺