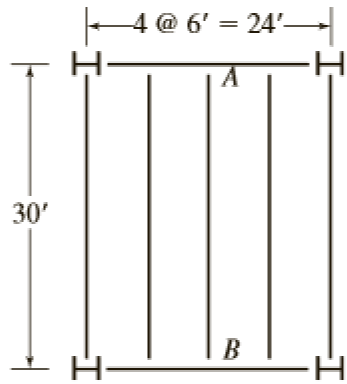
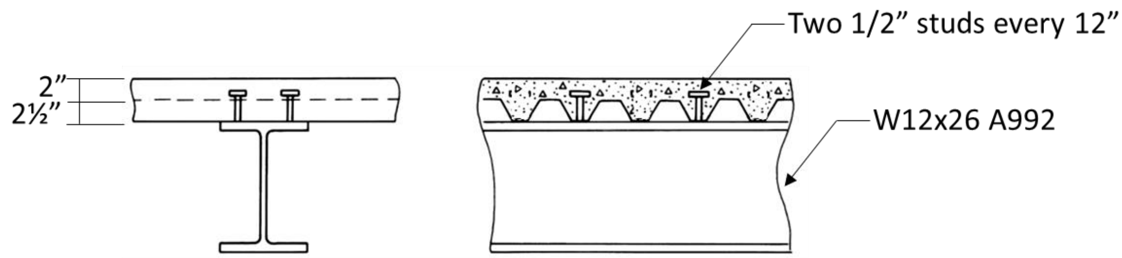
UC Berkeley | Comprehensive Exam
Civil and Environmental Engineering | **Structural Design** | Spring 2021
SEMM

The beam *A-B* in the floor shown below has one of the designs below. Assuming the beams have pinned ends and that the strength of beam *A-B* controls the design, determine the maximum permitted factored distributed floor load (in psf).

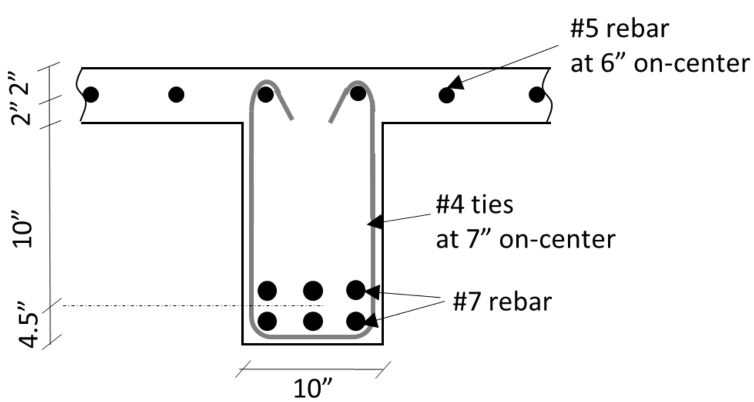
- For this problem choose EITHER composite steel OR concrete for your problem. Do not do both! Clearly state at the top of your solution which material you will use.
- Show all required work. If you are stuck, make an assumption to move you forward. Clearly state ALL assumptions.



Steel: The slab is normal weight concrete with a strength of f'_c = 4 ksi.
Q_n for one ½” stud = 6.51 kip
W12x26: A = 7.65 in, d = 12.2 in, I_x = 204 in4, t_w = 0.23 in, b_f = 6.49 in, t_f = 0.38 in
A992: f_y = 50 ksi



Concrete: The slab and beam are normal weight concrete with a strength of f'_c = 4 ksi. The rebar has F_y = 60 ksi.



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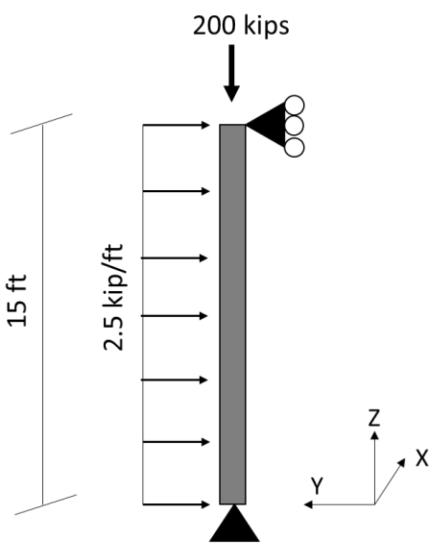
A 15’ column is part of a frame that is sideway inhibited in both directions. The column is pinned at top and bottom. The controlling factored load combination is shown below with lateral distributed loading from wind causing bending about the X-axis.

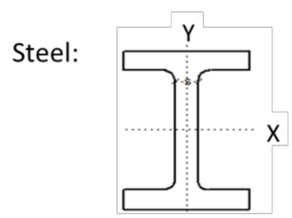
<u>Choose either steel *or* concrete</u> to complete this problem. Do not do both!

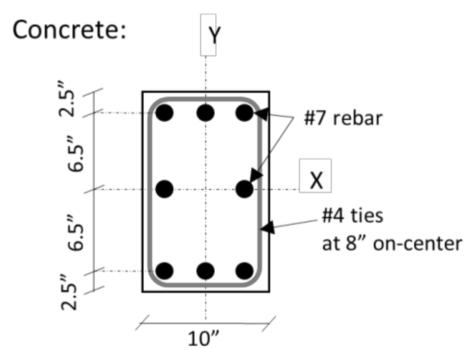
Steel: (a) What limit states do you need to check for? (b) Is a W12x45 with A992 adequate?

	***A* (in^2)**	***d* (in)**	**b_f (in)**	**t_w (in)**	**t_f (in)**	**$b_f/2t_f$**	**h/t_w**	
W12X45	13.1	12.2	8.05	0.335	0.575	7.00	29.6	
	I_x (in^4)	**Z_x (in^3)**	**S_x (in^3)**	**r_x**	**I_y (in^4)**	**Z_y (in^3)**	**S_y (in^3)**	**r_y**
	348	64.2	57.7	5.15	50	19.0	12.4	1.95
	***Lp* (ft)**	**L_r (ft)**						
	6.89	22.4						

Concrete: (a) What limit states do you need to check for? (b) Is the section drawn below with f'_c = 4 ksi and F_y = 60 ksi adequate?



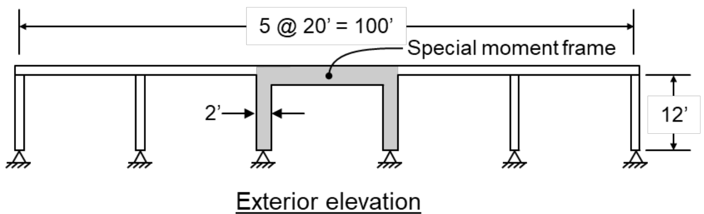


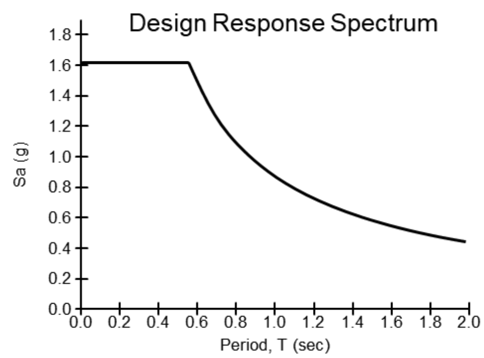


NAME:___________________________________

Comprehensive Exam - Structural Design

A small office building with square floor plan is braced by single-bay moment frames located around the building perimeter, with one moment frame per side. A typical elevation is shown. The remainder of the framing is of either reinforced concrete flat-plate framing supported on columns or concrete on metal deck supported by pin-ended beams and columns, and can be classified as gravity framing not designated as part of the seismic-force-resisting system. Service loads comprise self-weight, which can be taken as 100 psf acting on the floor area, plus 50 psf live load. The building is located in a region of high seismicity, with calculated vibration period of $T = 0.2$s. The design earthquake response spectrum is shown. Note that the design earthquake response spectrum represents elastic response of a single-degree-of-freedom oscillator with 5% of critical damping subjected to ground shaking with approximately 475-year return period.





(a) Estimate (with supporting calculations) the design base shear for the building along one of its principal axes.

(b) Estimate the design moment M_u for a moment frame beam at the face of the column.

(c) Assume the beam is efficiently designed for $\phi M_n = M_u$. Estimate the maximum axial tension that might reasonably occur at one of the pin supports supporting the moment resisting frame.