UC Berkeley	
Civil and Environmental Engineering	Structural Design
SEMM	_

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.

Choose either steel or concrete to complete this problem. Do not do both!

	A (in <sup>2</sup> )	<i>d</i> (in)	$b_f(in)$	$t_w$ (in)	t <sub>f</sub> (in)	$b_f/2t_f$	h/tw	
	13.1	12.2	8.05	0.335	0.575	7.00	29.6	
45	$I_x$ (in <sup>4</sup> )	$Z_x$ (in <sup>3</sup> )	$S_x$ (in <sup>3</sup> )	<i>r</i> <sub>x</sub>	$I_y$ (in <sup>4</sup> )	$Z_y$ (in <sup>3</sup> )	$S_y$ (in <sup>3</sup> )	<i>r</i> <sub>y</sub>
12X	348	64.2	57.7	5.15	50	19.0	12.4	1.95
M	<i>Lp</i> (ft)	$L_r$ (ft)						
	6.89	22.4						

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

**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?



University of California, Berkeley Spring Semester 2019 Civil and Environmental Engineering Structural Engineering, Mechanics, and Materials

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 = 0.2s. 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.

University of California, Berkeley Spring Semester 2018 Civil and Environmental Engineering Structural Engineering, Mechanics, and Materials

NAME:

MS Comprehensive Exam - Structural Design

A rigid block is supported on four columns laid out on a 28 ft by 28 ft grid. The columns are supported on a rigid foundation on a very stiff rock. The columns are fixed against rotation at both ends. Weight W comprises 1400 kips service dead load and 400 kips service live load. You may otherwise ignore self-weight. Total design lateral load V is 400 kips, which was calculated from the design earthquake loading using ASCE 7 including permissible force reduction factor  $R/I_e$ . For this problem, assume the load V acts in one horizontal direction and ignore loading in the orthogonal horizontal direction and the vertical direction. The columns can be either structural concrete or structural steel. If concrete, use  $f_c = 4000$  psi and Grade 60 steel, and assume the column has square cross section. If steel, use A36 steel. An engineer has completed preliminary designs for both steel and concrete, with the resulting nominal strengths shown.



(a) In this sentence, underline either *structural concrete* or *structural steel* to indicate the material you will use for your design.

(b) Calculate the shear force, moment, and axial force in each column due to the lateral force V.

(c) Use the LRFD method to assess whether the column moment design is sufficient for the specified loads. You may ignore second-order effects.