CE 120 – Spring 2020
Instructor: M.J. DeJong Name:_____

CE 120 – Structural Engineering

Mid-Term Examination No. 2

Instructions (as posted on bcourses prior to the exam):

- The exam is open book (i.e. reader) and open notes (including HW solutions). You are not permitted to use other materials.
- You may use a calculator and watch, but no other electronic devices are permitted. (Note: you may use a tablet to write your solution).
- You are not permitted to communicate with any other people during the exam.
- Do all problems. Show all relevant work.
- You may write your solutions on the exam directly, immediately following the problem statements. Or you may use your own paper, but please clearly write the problem number at the top of each page, and use a new piece of paper for each problem.
- Please make sure to upload the pages in the correct order.
- Organize and write solutions neatly. Points may be taken off for messy solutions.
- Indicate units in final solutions. Points will be taken off if units are missing or signs are unclear.

* If you have any questions, I will be available by zoom. Please logon to zoom, ask your question, and then logoff.

* Zoom Meeting ID: 922-154-494 (same as in your calendar)

By submitting your exam, you are agreeing to the following Honor Pledge:

"I have neither given nor received aid during this examination. I have not concealed any violation of the Honor Code. I did not use any unapproved notes or electronic devices during the examination."

Possible Points	Score	
Problem 1	25	_____
Problem 2	25	_____
Problem 3	25	_____
Problem 4	25	_____
TOTAL	100	_____

** **Figure 1** below shows two views of a four-story building which is to be used for Problems 1 and 2.

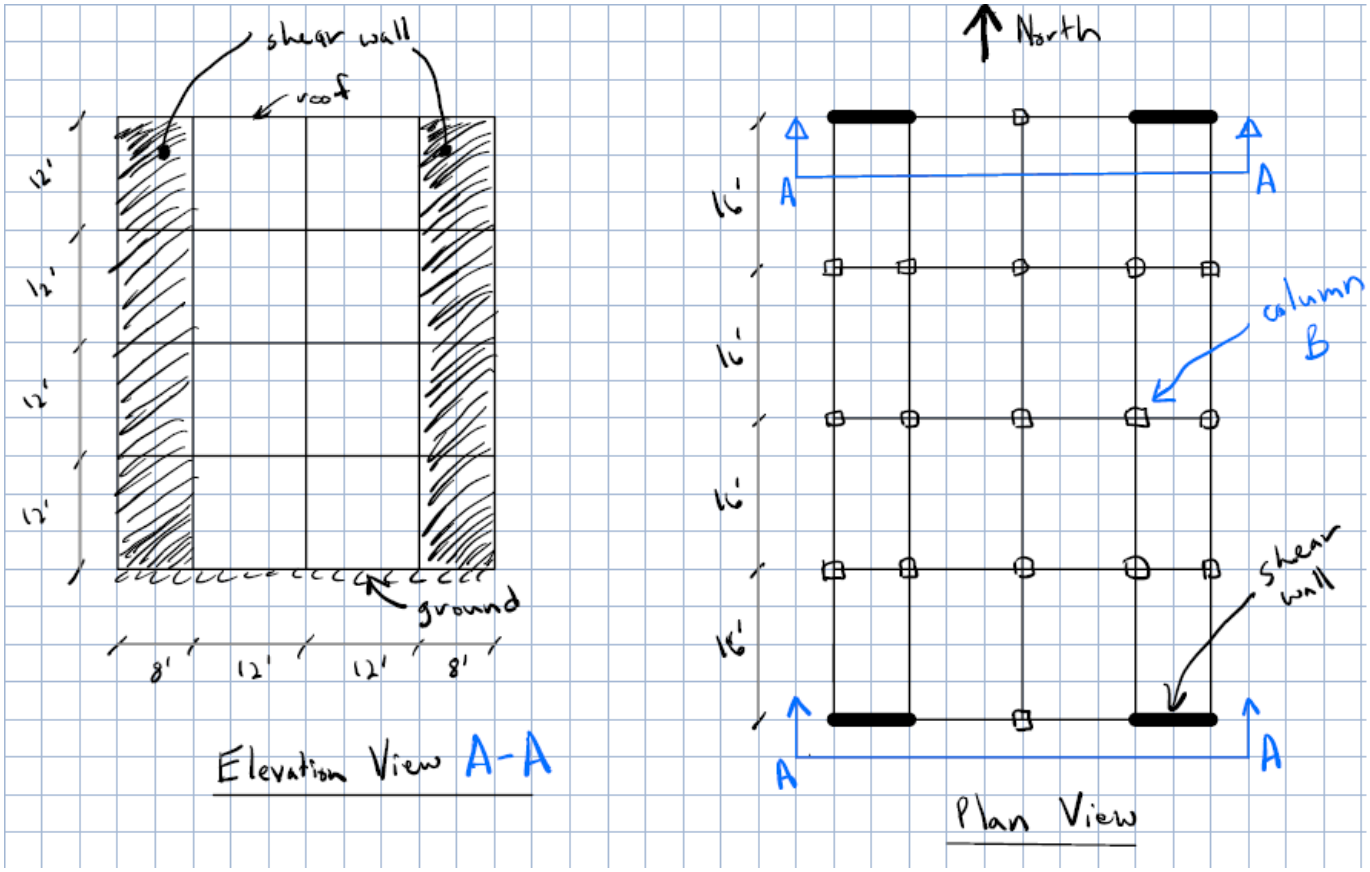


Figure 1

CE 120 – Spring 2020
Midterm Exam 2

Problem 1 (25 points) – The enclosed building in Figure 1 needs to be designed for wind load. Only consider wind coming from the west. Assume that the windward pressure is 30 psf and that the leeward pressure is 10 psf. Assume that both the windward and leeward pressures are constant over the entire height of the building.

(a) Calculate the design shear force at the base of one of the four shear walls.

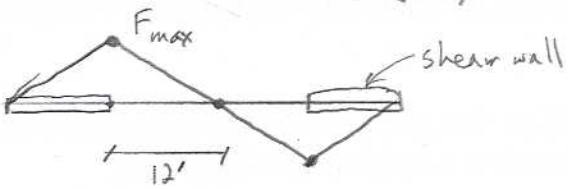
(b) Calculate the maximum collector force at the roof level.

(a) $F_{wind} = (30\,psf + 10\,psf)(4 \times 16')(3.5 \times 12') = 107.5\,k$

$V_{base,\,wall} = \frac{107.5}{4} = \underline{\underline{26.9\,k}}$

(b) @ roof: $(30\,psf + 10\,psf)(4 \times 16')(6') = 15.36\,k$

on one side: $w = \frac{15.36}{2(40')} = 192\,plf$



$F_{max} = 192\,plf\,(12') = \underline{\underline{2.3^{k}}}$

CE 120 – Spring 2020
Midterm Exam 2

Problem 2 (25 points) – The building shown in Figure 1 has:

- 6-inch thick concrete floor slabs, and a 4-inch thick concrete roof slab. Assume the density of concrete is 150 pcf.
- The dead-load at each floor is 50 psf (in addition to the floor slab weight).
- The dead-load at the roof is 30 psf (in addition to the roof slab weight).
- The exterior cladding weighs 20 psf.
- The floor live load is 60 psf on all floors.
- The roof live load is 20 psf.

(a) Determine the design dead load and live load at the base of column B in Figure 1. Do not consider load factors. Do include the live load reduction factor.

(b) Considering only the dead load, determine the seismic weight of one of the floors.

(a) Roof DL: $\left(150_{pcf}\left(\frac{4}{12}\right) + 30_{psf}\right)(10' \times 16') = 12.8^{k}$

Floor DL: $\left(150\,psf\left(\frac{6}{12}\right) + 50\,psf\right)(10' \times 16') = 20^{k}$

L_D Total DL $= 12.8^{k} + (3 \times 20^{k}) = \underline{\underline{72.8^{k}}}$

$L_{floor} = L_o\left(0.25 + \frac{15}{\sqrt{4(160 \times 3)}}\right) = 0.59 L_o = 0.59(60) = 35.6\,psf$

$L_{roof} = 20\,psf$

L_D Total LL $= \left[20 + (35.6 \times 3)\right](10' \times 16') = \underline{\underline{20.3^{k}}}$

(b) DL: $\left(150\,pcf\ \frac{6}{12} + 50\right)(64' \times 40') = 320^{k}$

Cladding: $(2 \times 64' + 2 \times 40')(20\,psf)(12') = 49.9^{k}$

Total $= 320 + 49.9 \approx \underline{\underline{370^{k}}}$

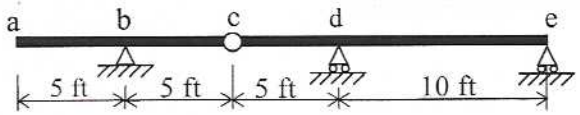
CE 120 – Spring 2020
Midterm Exam 2

Problem 3 (25 points) –The beam shown is subjected to a single point live load of 10 kips that can be applied anywhere, and a 2 klf live load which can be applied to any portion of the beam. All loads only act downwards.

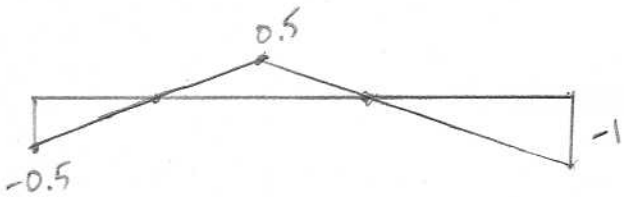
(a) Draw the influence line for the shear at point e.

(b) Draw the influence line for the moment at point b.

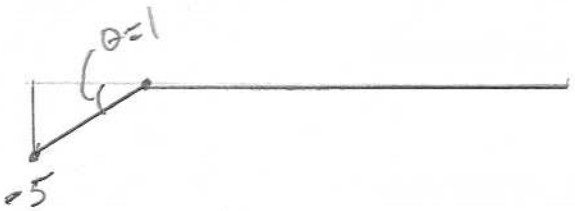
(c) Determine the maximum magnitude (either positive or negative) of the moment at point b.



(a)



(b)



(c)

$$M_b(1) + (-10^k)(-5) + (-2\,klf)(-5 \times 5' \times 1/2) = 0$$

↑ [+] ↻

$$M_b = -75 \text{ k-ft}$$

CE 120 – Spring 2020
Midterm Exam 2

Problem 4 (25 points) – A pin-jointed truss is shown in Figure 3. The axial stiffness of each member is EA = 10,000 kips.

For the loading shown, determine the horizontal displacement of point C.

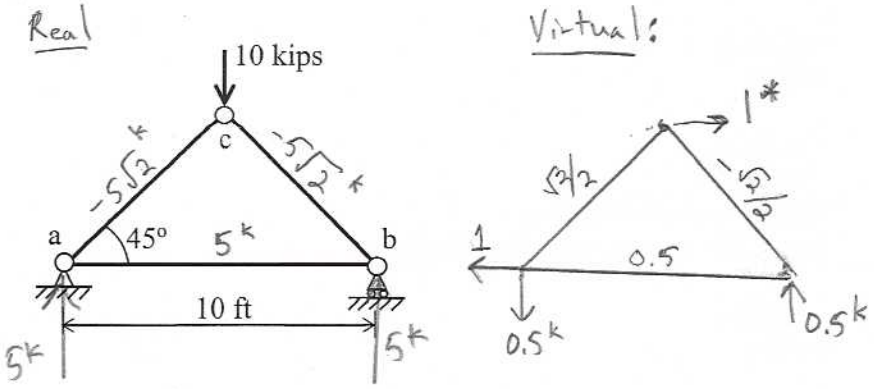


Figure 3

Member	l_i	P_i	$e_i = \frac{P_i l_i}{EA}$	P_i^*	$P_i^* e_i$
ab	10′	5	5×10^{-3}	0.5	2.5×10^{-3}
bc	$5\sqrt{2}$′	$-5\sqrt{2}$	-5×10^{-3}	$-0.5\sqrt{2}$	3.54×10^{-3}
ac	$5\sqrt{2}$′	$-5\sqrt{2}$	-5×10^{-3}	$+0.5\sqrt{2}$	-3.54×10^{-3}

$\Sigma = 2.5\times10^{-3}$

$1^* \delta_{ch} = 2.5\times10^{-3}$

$\hookrightarrow$ $\delta_{ch} = 2.5\times10^{-3}$ ft = 0.03 in.

Alternative Solution:

By symmetry: $\delta_{b,\text{horizontal}} = 2\,\delta_{c,\text{horizontal}}$

$$\delta_{b,h} = \frac{P_{ab} l_{ab}}{EA} = 5\times10^{-3} \text{ ft}$$

$$\delta_{c,h} = \frac{1}{2}\left(5\times10^{-3}\right) = 2.5\times10^{-3} \text{ ft}$$