

HOMWORK PACKET NO. 1 — VERTICALITY

ARCH 234 — Structures I

Due: Thursday, February 28, 2019 (50 points)

The students will form into teams to collaborate on problem sets and exam preparation. Collaborative activities are part of the learning a learning process. In order to optimize learning, the instructor requires that homework problems have open-ended short answer questions, and practice exam problems have closed-ended multiple choice questions. The students engage work in this cycle: (1) each team meets to discuss the learning objectives; (2) each student addresses the assigned homework problem set problem in the role of learner, solver, and or mentor; (3) each team meets and discusses each problem until fully understood; (4) the team submits one homework problem set where each student is in agreement with each solution with the students' roles clearly identified on Page 2; (5) each student completes a series of practice problems independently; (6) each team meets to review the instructor assessment of each homework problem; (7) each team meets to discuss the practice problems until all the learning objectives are fully understood; and (8) any student that is still having difficulty is encouraged to meet with the instructor and repeat the procedure as necessary. Please indicate one or two team captains that did a majority of the work (if applicable). Please note that the homework problems and practice exams are intended to closely shadow the learning objectives . . . **Neatness Counts!!!**

Team Name _____

Student 1: _____

Student 2: _____

Student 3: _____

Student 4: _____

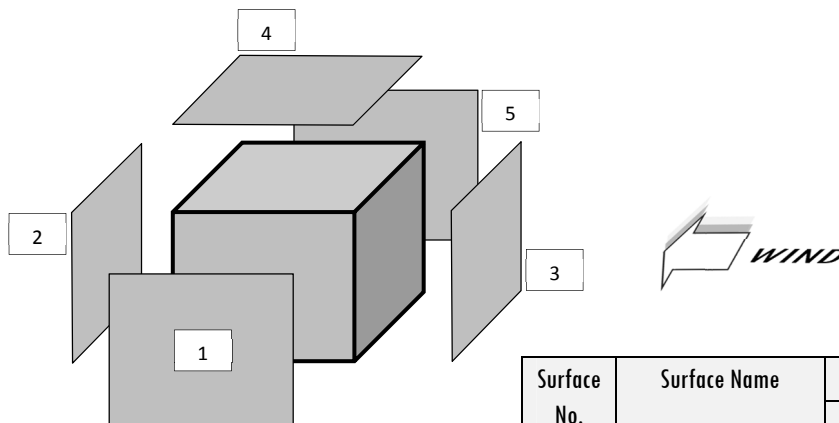
Team Captain(s) _____

HOMEWORK PACKET NO. 1 — VERTICALITY

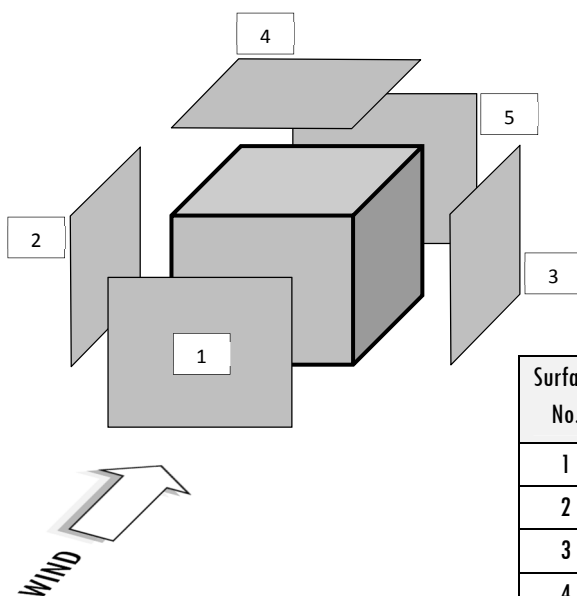
ARCH 234 — Structures I

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1. An exploded isometric of a box illustrates the five building envelope surfaces above grade that may be exposed to wind pressures. Identify in the tables below using a “✓” the: (A) name of the surface; (B) positive or negative pressure on the surface induced by the wind force; and (C) whether the pressure is generally considered as a constant or varies based on the height. Consider two different wind directions.

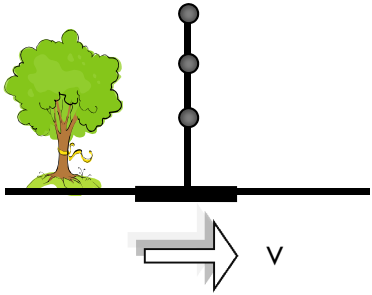


Surface No.	Surface Name	Pressure Direction		Pressure Magnitude	
		Positive	Negative	Constant	Increasing
1					
2					
3					
4					
5					



Surface No.	Surface Name	Pressure Direction		Pressure Magnitude	
		Positive	Negative	Constant	Increasing
1					
2					
3					
4					
5					

2. Compute the earthquake design base shear (V) using 12.5% of the total building weight. The 'dead' weights assigned to the 2nd, 3rd, and Roof are 300,000, 300,000, and 200,000 /bs, respectively.*



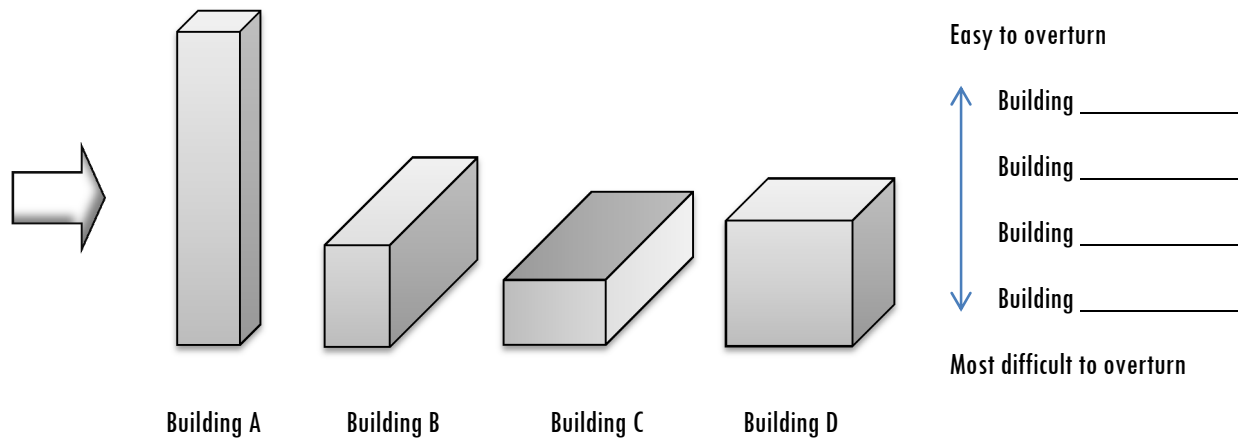
- 3. Identify five building behaviors induced by lateral forces.**

4. Draw two conditions of vertical structural irregularity and two conditions of plan structural irregularity.

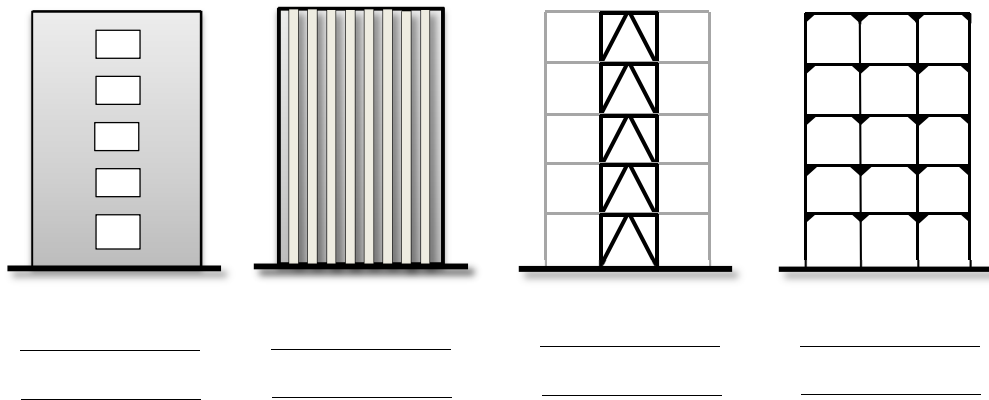
Vertical Structural Irregularity

Plan Structural Irregularity

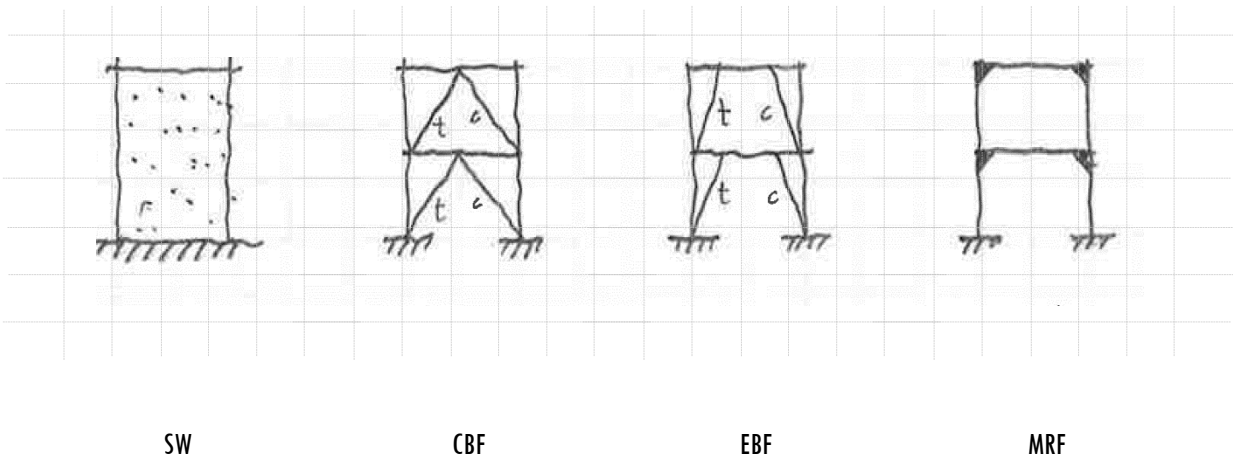
5. Rank the overturning difficulty from easiest to most difficult based exclusively on the building forms. The wind pressure is acting from the left to the right. Each building has the same volume and weight.



6. Identify the four different building stabilization methods shown in the drawings below.



7. Draw a two-story shear wall, concentric braced frame, eccentric braced frame, and moment-resistive frame.



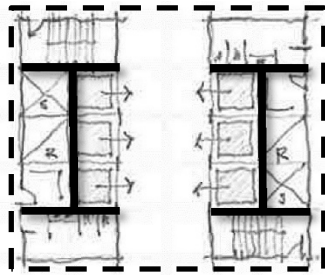
8. Rank the frames' hierarchal characteristics from greatest to least.

Hierarchy	Stiffness	Architectural flexibility
Least  Greatest		

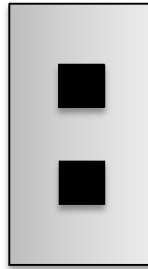
9. Describe the stabilization methods used for the Seagram building, Citicorp, 780 Third Avenue, and One Shell Plaza.

Building	Stabilization Description
Seagram	
Citicorp	
780 Third Avenue	
One Shell Plaza	

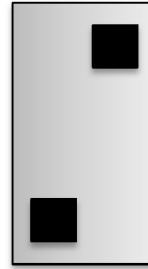
10. Each building has two vertical service cores. Each core has six shear walls of comparable stiffness (shown below) which provide two I-shaped frame configurations. Which of the four service core arrangements is the most problematic for a structural designer to stabilize a tall building?



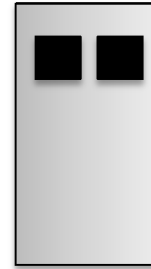
Service Core



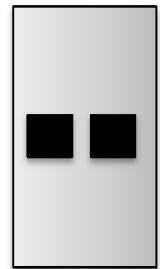
A



B

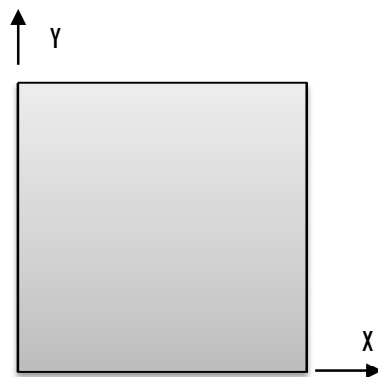


C

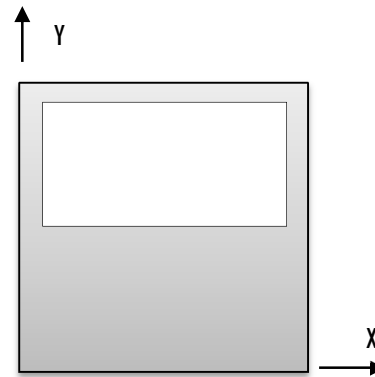


D

11. Locate the approximate location for the center of force (X_{cf} , Y_{cf}) on the plans shown below. Find the center of wind force for the plan on the left. Find the center of earthquake force on the plan on the right with an atrium space. Use a “●”.

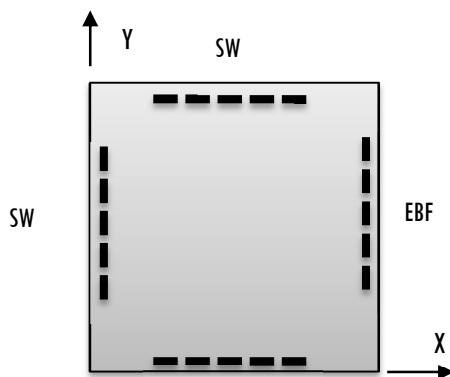


Center of Wind Force

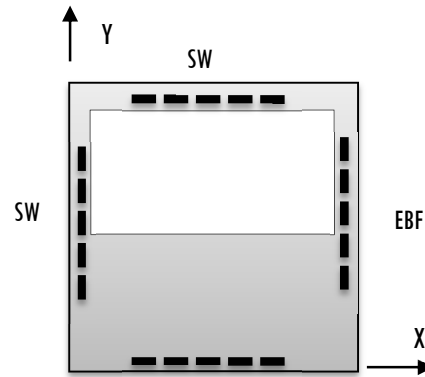


Center of Earthquake Force

12. Locate the approximate location for the center of stiffness (X_{cs} , Y_{cs}) on the plans shown below. The floor plans have two eccentric braced frames and two shear walls. The shear walls are about four times the stiffness as the eccentric braced frames. Use a “○”.

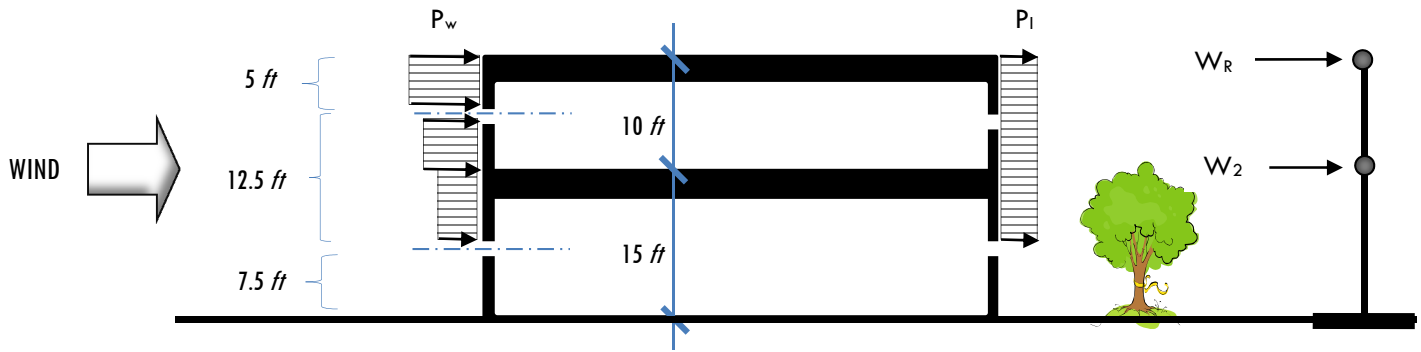


EBF

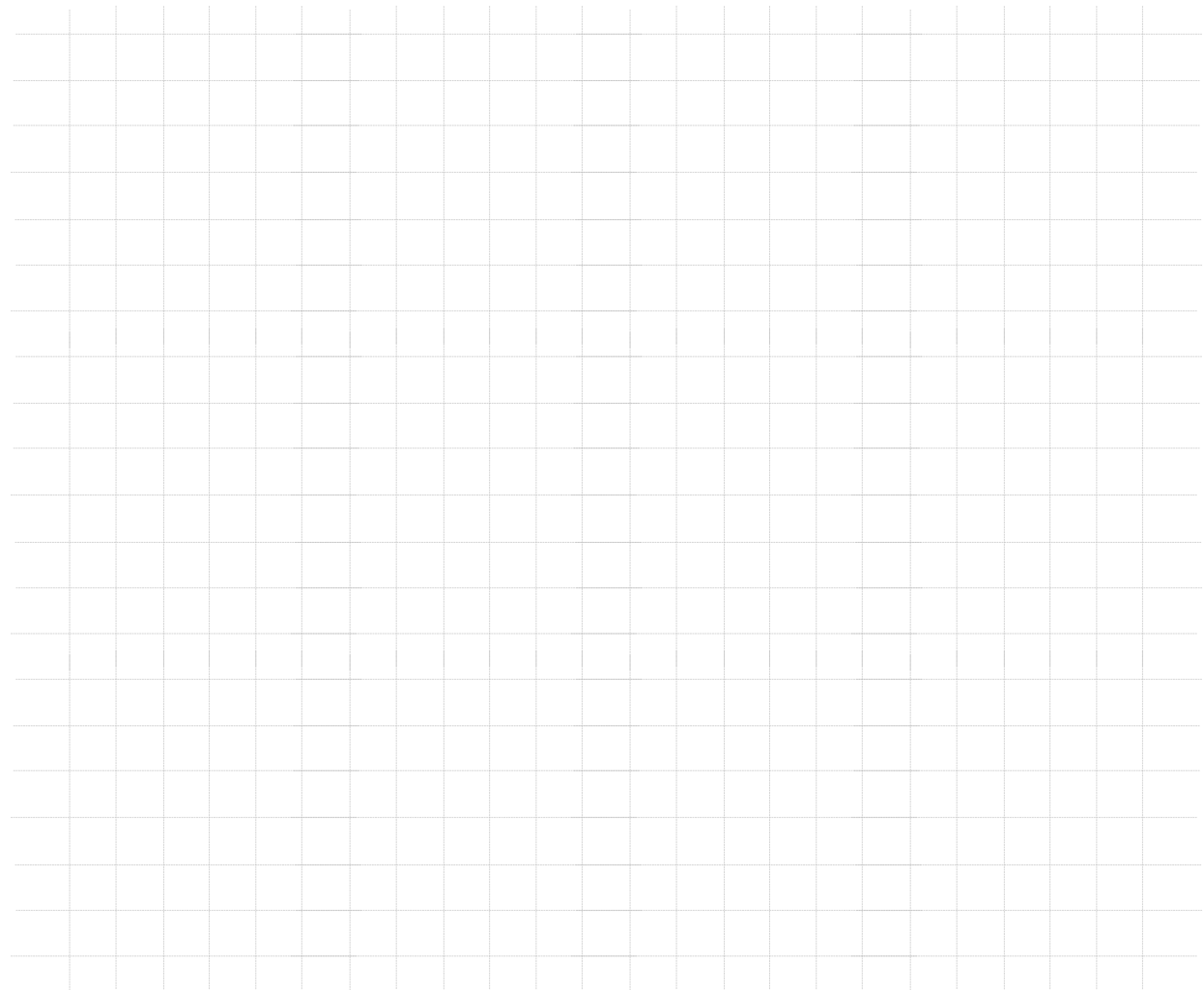
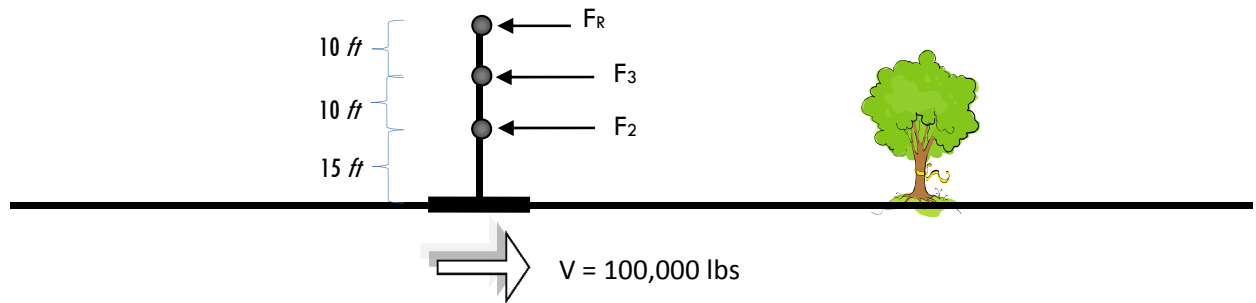


EBF

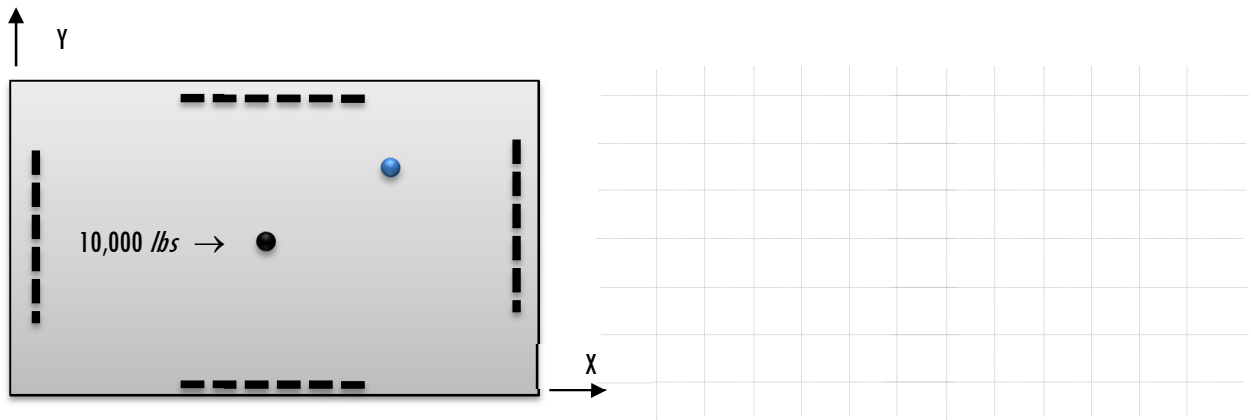
13. Determine the horizontal story forces at Floor 2 (W_2) and the Roof (W_R). The wind direction is normal (90°) to the longitudinal direction of the building (the big wall is the windward wall). The box building is 50 *ft* wide x 100 *ft* long x 25 *ft* tall. The second floor is located at 15 *ft* from the ground and the roof is located at 25 *ft* from the ground. There is no parapet. The windward pressures are: +16.6 *psf* from 0-15 *ft*, +17.6 *psf* from 15-20 *ft*, and +18.4 *psf* from 20-25 *ft* from the ground. The leeward pressure is -10.4 *psf*.



14. Compute the earthquake story forces at Floors 2 (F_2), 3 (F_3), and Roof (F_R) levels due to a 100,000 lbs design base shear. The weights assigned to the 2nd, 3rd, and Roof levels are 400,000, 400,000, and 200,000 lbs, respectively.* The total height is 35 ft (15+10+10). Use $C_t = 0.020$.



15. Identify the equivalent force characteristics when the wind force of 10,000 *lbs* moves from the center of wind force ($X_{cf} = 40$ *ft*, $Y_{cf} = 30$ *ft*) to the center of stiffness coordinate location ($X_{cs} = 60$ *ft*, $Y_{cs} = 45$ *ft*). (1) Draw the equivalent force conditions (force and torsional moment arrows) and (2) Compute and label the wind force and the torsional moment at the (X_{cs} , Y_{cs}). Show your work.*



16. Draw a sectional example of a flexible diaphragm and a rigid diaphragm.

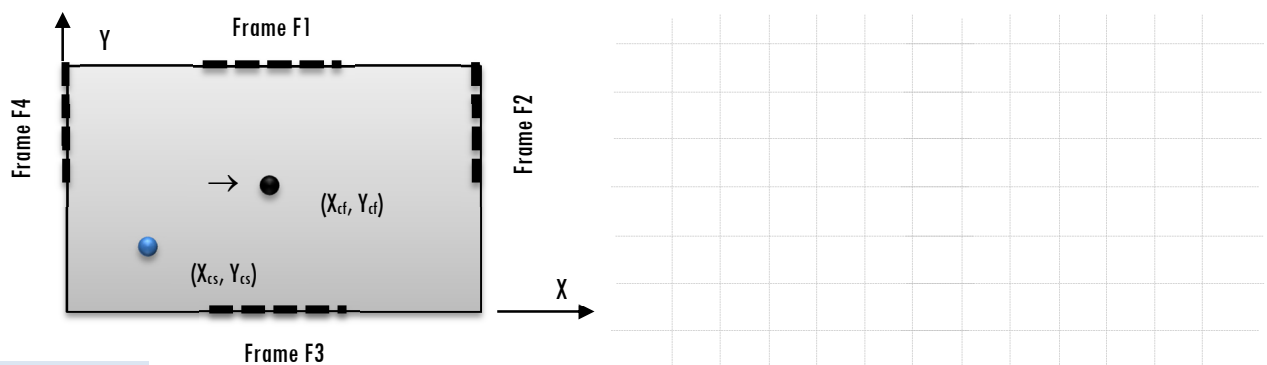


Flexible diaphragm

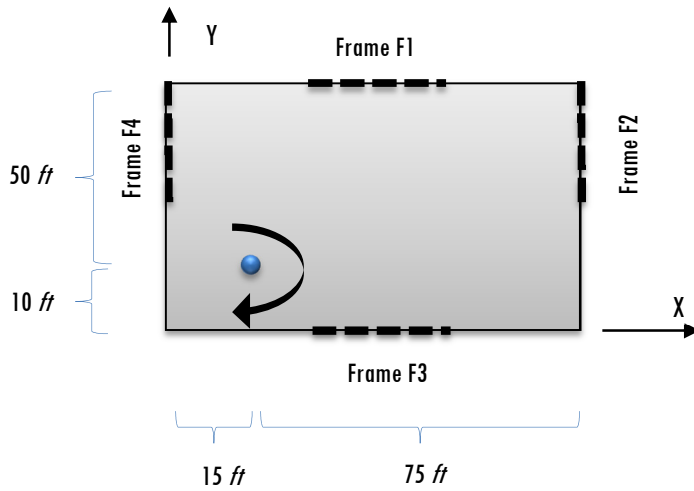


Rigid diaphragm

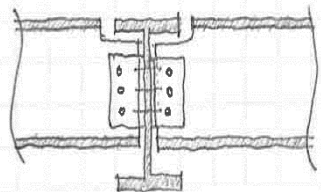
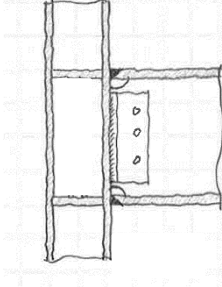
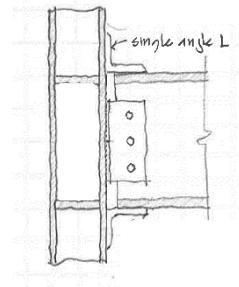
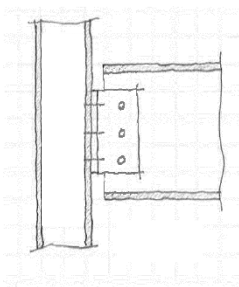
17. Compute the direct shear force in Frame F2 and Frame F3 and identify the force direction when the total wind force is 15,000 *lbs*. Frames F1 ($k_x = 1,000$ *lb/in*) and F2 ($k_y = 1,000$ *lb/in*) are EBFs, while F3 ($k_x = 5,000$ *lb/in*) and F4 ($k_y = 5,000$ *lb/in*) are SWs. The diaphragm is rigid. Show your work.*



18. Compute the torsional shear forces in each frame when the building is subjected to a $97,500 \text{ ft-lb}$ moment at the center of stiffness (15 ft , 10 ft). Frames F1 ($k_x = 1,000 \text{ lb/in}$) and F2 ($k_y = 1,000 \text{ lb/in}$) are EBFs, while F3 ($k_x = 5,000 \text{ lb/in}$) and F4 ($k_y = 5,000 \text{ lb/in}$) are SWs. The building is 90 ft by 60 ft . Show your work.*



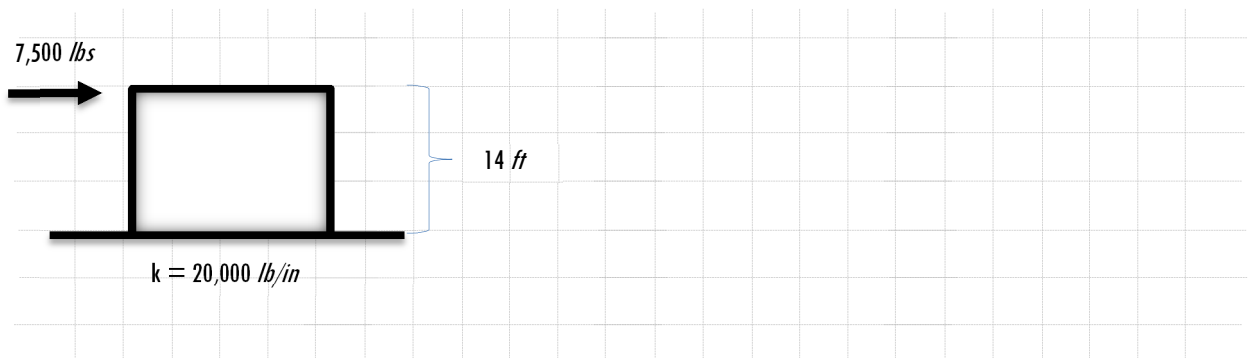
19. Classify the structural steel connection type as Type FR fully-restrained against rotation, Type PR partially-restrained, and Shear (no restraint) from the connections below.



20. Complete the table by inserting the connection type (FR or Shear) in the appropriate cells. Consider a structural steel building.

Stabilization Method	Connection Type			
	Beam-to-girder		Beam / Girder-to-column	
	Interior	Exterior	Interior	Exterior
Rigid Perimeter Building				
Rigid Frame Building				
Braced Building				

EC1. Compute the total building drift, the code limiting value, and determine if the drift is acceptable. Show your work.*



Your Score = _____ %

Class Average = _____ %