Study Questions

Problem 1   Drift, velocity and acceleration (walled building)

Use the EVW app to analyze the 12-story walled building shown in Figure 1. The building has a damping ratio of 2%. Story stiffness is 5000.0 k/in. For wind, assume an exposure category B and a gust wind speed of 95.0 mph. Total building weight is 30000.0 kips and is equal for all floors including the roof. Also $F_y = 60$ ksi and hardening ratio, $b = 0.02$. Analyze the building using both PDelta enabled and disabled. Explore the followings:

a) Maximum roof drifts under wind and earthquake loading

b) Maximum first story and 12th story drifts for the two load cases. How do these compare with the maximum roof drift?

c) Maximum story velocity

d) Maximum story acceleration

e) Why are story drift, verlocity and acceleration important quantities to consider?

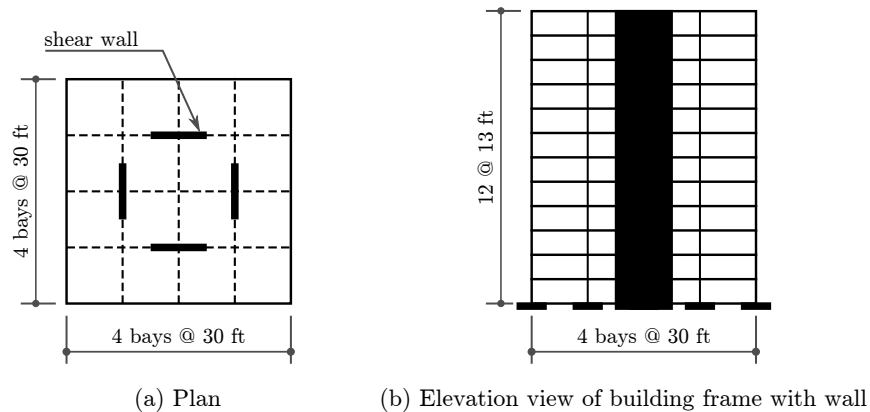(a) Plan   (b) Elevation view of building frame with wall

Figure 1: Geometries of the 12-story building.

Problem 2   Effect of damping ratio (walled building)

Analyze the building of Problem 1 (Figure 1) again but this time use a damping ratio of 5% and compare the results of the two problems and explain the differences. Which building is safer when exposed to the same earthquake excitation? What causes building damping? What might cause increased damping?

Problem 3   Effect of hardening ratio (walled building)

What happens if you analyze the building shown in Figure 1 with no hardering ratio ($b = 0$)? And what will change if hardening ratio is increased to $b = 0.05$? What properties determine the story hardening ratio?

Problem 4   Drift, velocity and acceleration (moment-resisting frame)

Considering *East-West* direction, for the moment-frame building shown in Figure 2 calculate the stiffness of the each story. For stiffness calculations only take the moment resisting frames into cosideration. Beam and column sections are given in Table 1. Columns in the moment resisting frame are bending about their strong axes.

Assume 2% damping for the building and exposure category B with a gust wind speed of 110.0 mph. Loading is as follows:

Story	Dead load (psf)	Live load (psf)
Floors	100	20
Roof	80	15

While $F_y = 50\,\mathrm{ksi}$ and $b = 0$, analyze the building for both earthquake and wind using EVW app. Do not consider $P - \Delta$ effect. Explore the followings:

a) Maximum roof drifts under wind and earthquake loading

b) Maximum first story and 5th story drifts for the two load cases. How do these compare with the maximum roof drift?

c) Maximum story velocity

d) Maximum story acceleration

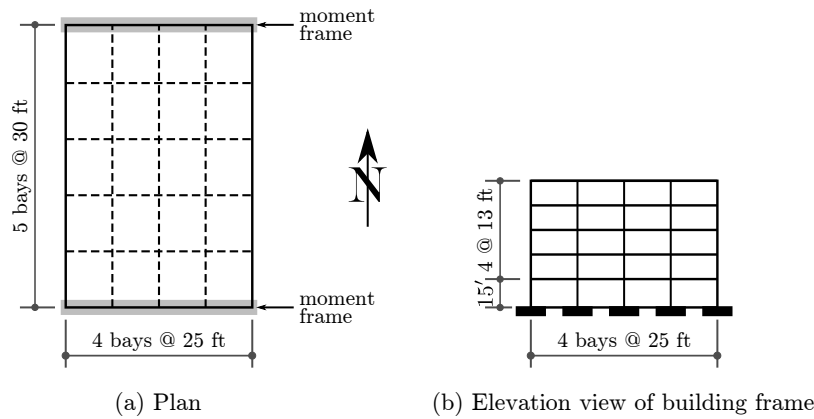e) Why are story drift, verlocity and acceleration important quantities to consider?

(a) Plan   (b) Elevation view of building frame

Figure 2: Elevation and plan of the 5-story steel moment-frame building.

Table 1: Beams and columns of the moment resisting frame.

Story/Floor	Columns	Beams
1/2	W14 × 311	W30 × 116
2/3	W14 × 311	W30 × 116
3/4	W14 × 311	W30 × 116
4/5	W14 × 311	W30 × 116
5/Roof	W14 × 257	W24 × 62

Problem 5   Effect of damping ratio (moment-resisting frame)

Redo the analysis of the building shown in Figure 2 for a damping ratio of 5% and compare the results of the two problems and explain the differences. What differences do you observe and why? What causes building damping? What might cause increased damping?

Problem 6   Effect of hardening ratio (moment-resisting frame)

Redo the analysis of the building shown in Figure 2 but use $b = 0.05$ and keep the damping ratio as 2%. Is there any changes? If yes, why and what is the effect of these differences on the overall behavior of the building? What properties determine the story hardening ratio?

Problem 7 $P - \Delta$ effects (moment-resisting frame)

Re-analyze the building shown in Figure 2 but this time account for $P - \Delta$ effects. Comment on the differences.

Problem 8 Stiffer building (walled building)

Re-analyze the building shown in Figure 1 but increase the stiffness by 25%. What observations can you make?

Problem 9 Stiffer building (moment-resisting frame)

Re-analyze the building shown in Figure 2 and increase the stiffness by 25%. What observations can you make?

Problem 10 Soft story (Walled building)

An architect decides to insert a door opening in the lateral resisting element (shear walls) of the building shown in Figure 1. The openings are only in the first story and reduce the story stiffness by 50%. Re-analyze this building, taking into account the opening in the shear wall, and compare the results with the original case. Comment on the results and observations you make.