

CEE 227 Earthquake Engineering Design

Study Questions for Last Exam

Some of the questions from the first set of review questions that relate to performance based design, establishing and interpreting design criteria, capacity design, and the analysis of the nonlinear response of multiple degree of freedom systems may be covered on the second exam. In general, any topics covered in class since about a week prior to the first midterm will be given priority. Topics that were explicitly covered on the first exam, or issues related to characterizing ground motion hazard, attenuation relationships, etc., will not be covered on the second exam.

1. (Review) If we are considering two spectra, one for which the structure should remain elastic in the event with a 50% probability of exceedence of occurrence in 50 years and the other where it may yield in an event where there is a 2% probability of exceedence in 50 years:
 - a. What is the maximum ductility you can use in conjunction with the 2/50-year event, such that the structure does not yield under the 50/50 year event?
 - b. How does this change conceptually, if you have:
 - i. A near-field 2/50-year event, but the 50/50 event is far-field (it will be smaller, but the shape of the spectrum will differ as well).
 - ii. A building in Berkeley and one in Memphis TN. Both have about the same 2/50 earthquake hazard, but the 50/50 hazard in Berkeley is much higher than in Memphis

2. For a multiple degree of freedom system, one has carried out a static pushover analysis, which plots the base shear vs. the roof displacement. You know the story masses, periods and mode shapes. Be able to represent this MDOF system as an equivalent SDOF system based on the first mode. We need to have the stiffness, mass, strength and post-yield stiffness of this SDOF system.

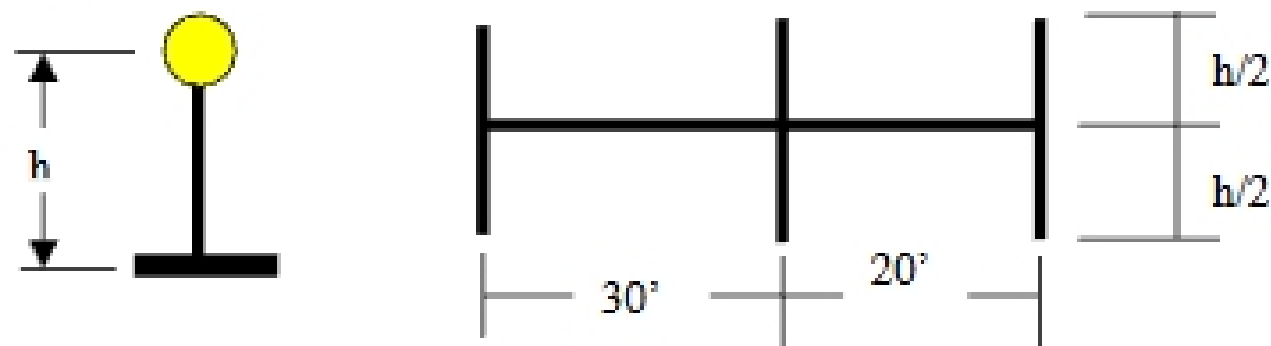
If one carries out an inelastic dynamic analysis of the SDOF system modeled above, and you obtain a peak displacement value of " x ," what would a good estimate of the roof displacement be for the MDOF system. If you get a base shear of Q_y for the SDOF system, what would be an estimate of the base shear in the MDOF system?

How would one estimate the interstory drift in a particular story in the MDOF system?

3. Consider any one of the idealized structures shown below. You are given the required Q_y to be resisted by the structure elastically under the effects of frequent seismic event, and the maximum lateral displacement Δ_{limit} that the structure should experience under these conditions. The same structure must be able to sustain

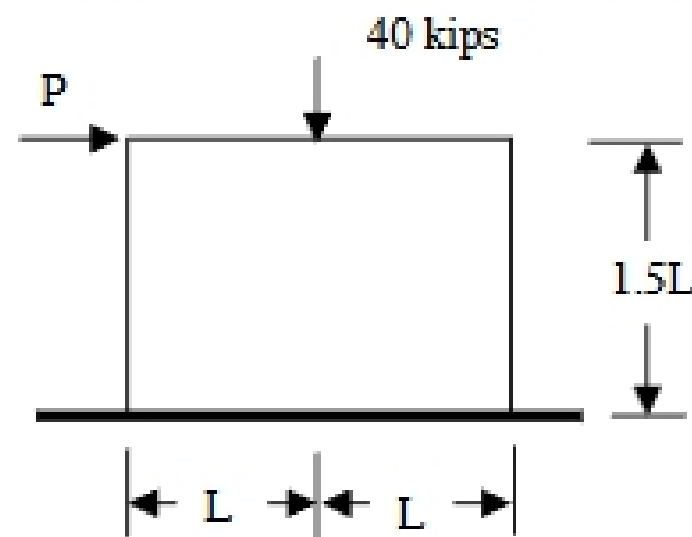
inelastically a very rare event that would require a design force of $Q_{elastic}$ if it were to remain elastic, but the maximum ductility demand on the structure should not exceed μ_{limit} , and the peak total displacement should not exceed Θ_{limit} (expressed as a fraction of the story height). Gravity-related forces need not be considered. You may assume that for the purposes of this problem we are in a range of dynamic response where “displacements are preserved.”

Assuming that the structure is to be designed from steel, what values of I , Z and S should be used in picking the final size of the members where yielding may be permitted? On the structure on the left, yielding is expected in the column, while in the structure on the right, the two girders are to be the same size, and the columns are not intended to yield.



4. A regular multistory building is designed for wind and seismic loading. Wind forces control the response for the upper two thirds of the structure and seismic controls only for the bottom third. Will the ductility demand on the elements of this structure be the same as for the case where seismic controlled for the full height? Qualitatively and briefly describe how would they differ? How might you alter the seismic design to improve performance

5. In the above structure, how could one rapidly estimate whether there is a plastic hinge (a) at the top of the columns or (b) along the midspan of the beams? That is, how would you do this without doing an analysis of the complete structure?



6. Using capacity design concepts, draw the critical design forces (moments and shears) along one of the beams shown below in which the ultimate failure is to be controlled by flexural plastic hinging. Specific values of M_p and transverse gravity loading would be provided.



7. Using plastic analysis concepts, how does the plastic rotation demand compare for the two designs shown below? The beam spans are both 30 feet. For the structure on the

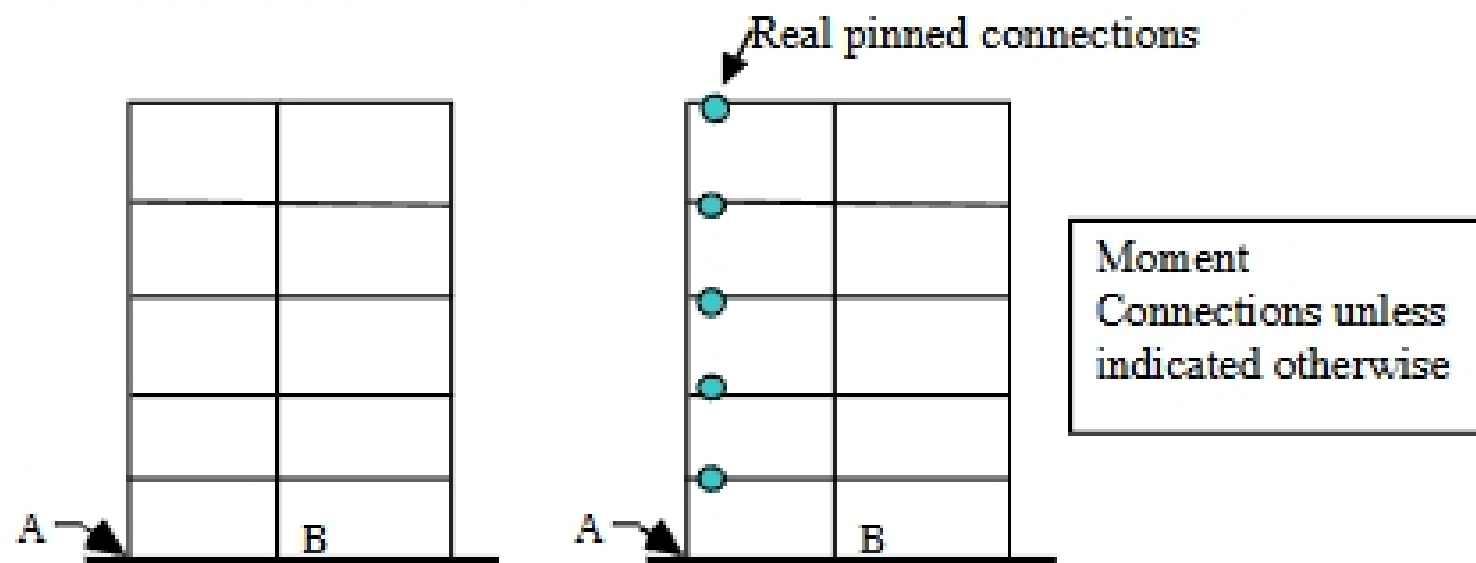
right, the plastic hinges are located 3 feet in from the column face. If you were designing both configurations to resist the lateral load capacity, what M_p would be required for the beam on the right at the plastic hinge location?



8. The plastic rotation capacity of a plastic hinge is 3%. For the following condition, which situation would achieve the least plastic rotation demand on the plastic hinges given the same interstory drift? The worst.



9. (May not be covered) How does one estimate the maximum design forces that might be considered using capacity design for the base plates in the structure designed as a strong column-weak girder system as shown below? The minimum (tensile) forces? How does one easily tell if the base plate at the bottom of columns A and B need to be designed to resist net tension?



10. Describe two (or three) conceptual ways in which seismic isolation helps protect buildings from earthquakes.
11. If a SDOF structure is isolated by friction bearings that yield in shear, for design one analyses its behavior using an equivalent elastic model with a modified period and damping ratio. However, if we have the same structure, and permit it to form a plastic hinge in flexure at its base, we use a nonlinear response spectrum. Should we use an equivalent elastic model for all structures that yield in shear? What gives?
12. Given the results of a static push over analysis, estimate the factor C_3 in FEMA 356, and the effect of geometric nonlinearities on the systems total displacements.