

CEE 227 -- Earthquake Resistant Design

Term Project

This term project is intended to provide the opportunity for you to study a topic addressed by CEE 227 in more depth, to integrate information from this course with what you have learned in other courses, or to apply techniques in more detail than permitted within the regular homework assignments. The term project contributes 35% of the course grade.

By March 10, 2009, provide a brief (half page) abstract of your project, indicating the subject, a narrative paragraph describing what you hope to achieve, and some references you intend to use. Full credit will be awarded for all submissions. I will use this abstract to help you refine (narrow) the scope of your project and locate useful sources of information. Earlier submissions are encouraged.

By May 7, 2009, prepare a written report on your project. This should include:

- a concise statement of objectives,
- a statement on how your topic relates to CEE 227,
- background information, citing appropriate references,
- the body of your report, and
- conclusions and observations.

Even if your project is doing a design or carrying out detailed analyses, you need to prepare a written narrative (though this can be brief, if you organize your other material).

Reports can be done individually, or better still, in groups of two. Group projects will be expected to demonstrate correspondingly more total work than individual projects. Groups are particularly encouraged where one team member, for instance, has background in nonlinear analysis and another in design, or where one has a background in geotechnical engineering and the other in structures, or one on probabilistic methods and the other in design. Groups of three or more are acceptable, but require prior approval of the instructor.

Ideally, we should have a very short oral presentation so everyone might benefit from what you have learned. We will discuss this option during class.

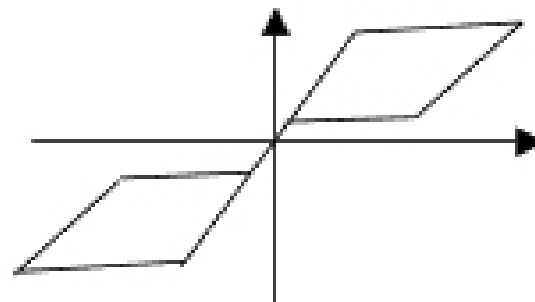
MS students in SEMM are required to take a Comprehensive Examination, unless they take at least 2 units of CE 299. Students may wish to consider adding units of CE299 with a professor of their choice on the topic of this project. This will avoid the need to study for and take the Comprehensive Exam, without significantly more work beyond that required to complete the CE 227 term report.

You can pick a topic of your own choosing! To stimulate thinking, some possible topics are listed below. You need not limit your topics to this list. A list of past topics is located at the end of this document.

Related to design of new structures (See later sections on Seismic Isolation, particular types of structures, tall buildings, etc.)

Redesign the class project building (or another structure you find in the literature) and compare your redesign and its performance with those of the original structure. Some ideas would be to consider one or a combination of the following:

- Modified moment frames for improved ductility using (FEMA350, AISC 441, AISC 353) “prequalified” details.
- Modified moment frames (configuration (number of frames, bay spacing, member depths, etc.) and proportioning (panel zone vs. beam yielding) to improve performance
- Modified braced frames (to help control drift), including buckling restrained braces, friction or other types of hysteretic devices.
- Supplemental viscous damping energy dissipation systems (viscous), for example, looking at the effect of different powers than one for velocity.
- Seismic isolation of various types to limit damage in the superstructure.
- Special bracing elements that would tend to make a structure re-center following a major earthquake, such as hydraulic springs by Jarret, shape memory alloys, or prestressed friction devices (e.g., see Christopolous). The hysteretic characteristics of such components are pinched in a flagpole shape as shown below.



Use of the PBE procedure in FEMA 350 to design the homework building more rationally and evaluate the confidence we have in it achieving its target performance. There are numerous levels of analytical methods and performance objectives that can be addressed with this methodology.

Application of course concepts to other types of structures (bridges, offshore structures, etc.)

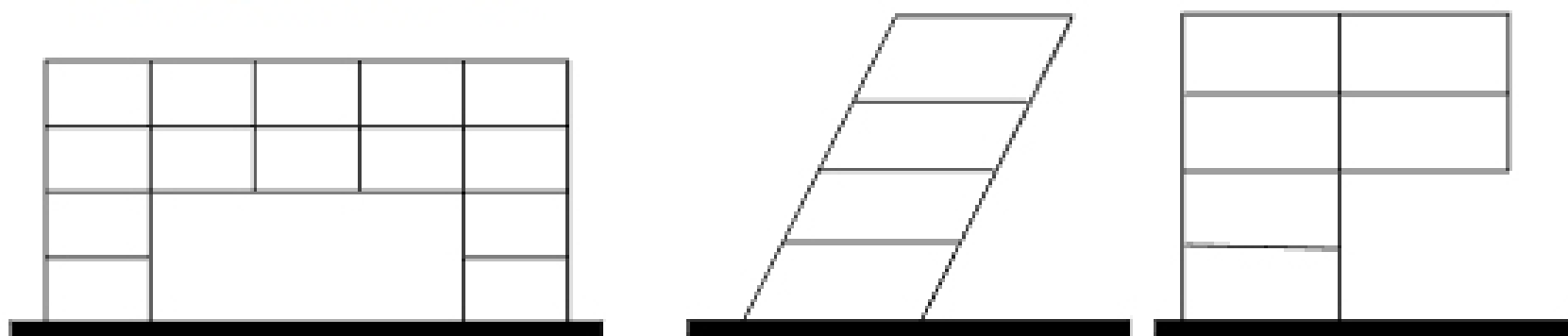
What happens if the foundations of a structure are allowed to uplift during an earthquake? Consider a structure like a braced frame or a narrow moment frame where there is net uplift on the footings, or a wider mat or spread foundation where there is only partial uplift along the edges of the foundation. Recently, architects like Renzo Piano, have designed structures where this is an explicit design feature and

viscous dampers (or perhaps, as an alternative, buckling restrained braces could be used) are included in the uplifting columns to help dissipate energy.

Application of issues related to soil-structure interaction (for example, the simplified methods contained in FEMA 368) to design. When is this important, does it help (yes) or hurt?

What is the effect of considering vertical ground motions? Carry out analyses of some simple building systems with different heights or floor spans considering or ignoring the vertical component of excitation. Consider the change of the relative character of the vertical ground motions (or spectra) with distance and earthquake magnitude. Look at structures, such as long span systems, prestressed systems, cantilever systems, cable suspended structures, etc., where vertical motions may generally be expected to be important.

Some architects are building new structures that are not uniform with height. Explore design issues related to these systems. For instance, see the schematic figures provided below.



Similarly, many architects are building systems that are not typical rectangular frames. Explore design issues related to such systems. For instance, see the figures shown below. In the first case, each floor is square, but each rotates about a vertical axis relative to the one below. The columns may be straight in such structures, but the beam-column frames are not planar. In the second, the vertical and lateral load resisting systems are merged, and there are no vertical columns, even at the corner of the buildings. What are the special challenges of this popular structure for high-rise buildings if yielding during earthquakes is permitted. What can be done to improve the behavior?

