University of California at Berkeley
Civil and Environmental Engineering

Instructor: Stephen A. Mahin
Spring Semester 2007

CEE 227 -- Earthquake Resistant Design

Term Project (revised Feb.4, 2007)

This term project is intended to provide the opportunity for you to look into 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

By March 1, 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. This abstract will be used to assist students in refining (narrowing) the scope of their project and locating useful sources of information. Earlier submissions are encouraged.

By May 8, 2006, prepare a written report on your project. This should include in some form:

- a concise statement of objectives,
- a statement on how it 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 report (though this can be brief, if you organize your other material).

Reports can be done individually, or in small groups. 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.

According to the class syllabus, the term project contributes about 35% of the semester grade.

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

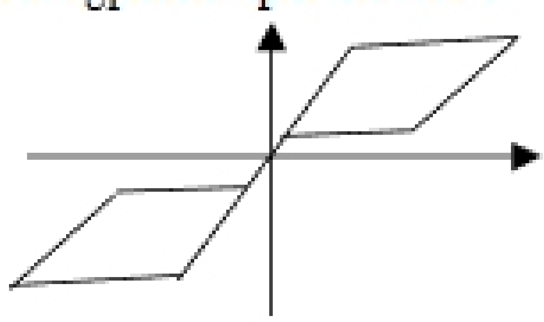
You can pick of topic of your own choosing!

To stimulate thinking, some possible topics are listed below:

Related to design of new structures (See later sections on Isolation, 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:

- 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 bucking 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. The hysteretic characteristics are pinched in a flagpole shape as shown.



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

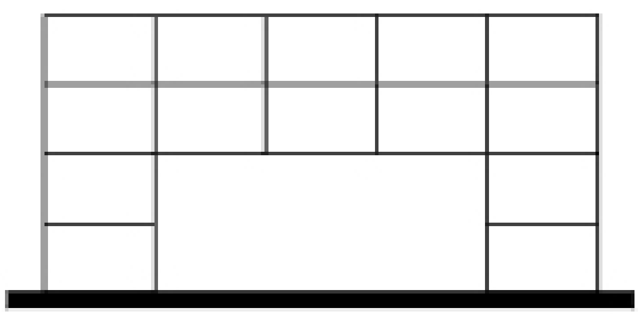
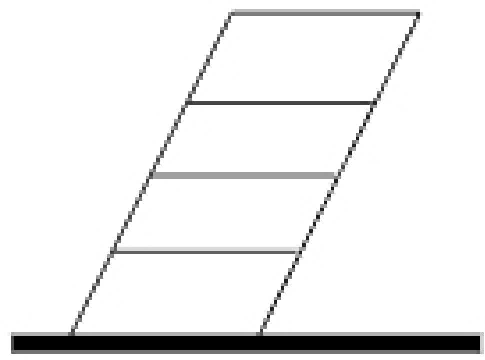
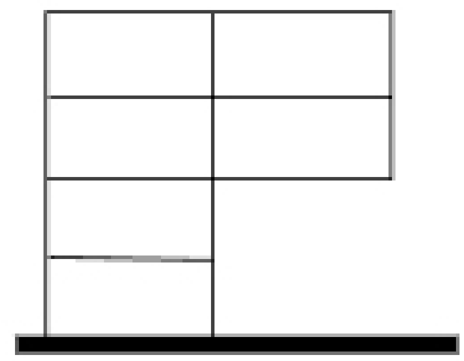
Application of course concepts to other types of structures (bridges, offshore structures, etc.)

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.

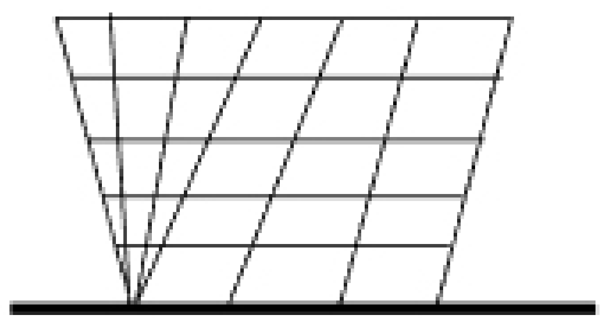
Application of issues related to soil-structure interaction (for example, the simplified methods outlined in FEMA 368) to design. When is this important, does it help (yes) or hurt?

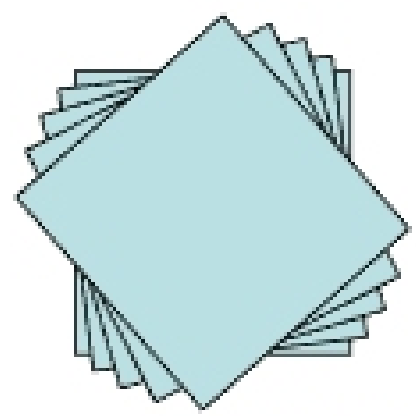
What is the effect of considering vertical ground motions? Carry out analyses of some simple building systems with different heights or floor spans considering or ignoring the vertical component of excitation. Consider the change of the relative character of the vertical ground motions (or spectra) with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

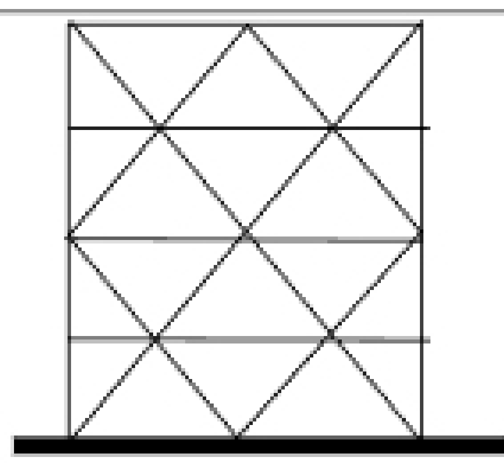
Some architects are building new structures that are not uniform with height. Explore design issues related to these systems. For instance, see the figures below.

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.


Elevation


Plan View


No Vertical Columns