

CEE 227 -- Earthquake Resistant Design

Introduction to Class Project Building

Most of the homework assignments this semester will be related to the design of a hypothetical structure to be constructed in Berkeley or the development and trial applications of simple tools that can be used in the design of such structures. The class homework assignment building is based on a theme building widely used in the literature. The original building was intended to be located in Los Angeles, but for the purposes of this class we will assume it is to be built in Berkeley, on a level rectangular site, located on firm soil approximately 2 km west of the Hayward Fault and 30 km east of the San Andreas Fault. The Hayward fault is assumed capable of generating an earthquake with a Richter magnitude of 7.2 and a magnitude 8+ earthquake is expected eventually on the San Andreas Fault. There are a number of smaller faults in the area. Thus, earthquake loads are a major design consideration in the overall design of this structure. Additional information on the seismic environment will be provided later.

For our hypothetical building, we will assume the owner intends to use it as a high-technology research facility, rather than as a normal office building (as envisioned in the original design of the building). Specifically, the building will have mixed use, housing a variety of nanofabrication labs, high performance computer workstations for computer-assisted engineering as well as space for developing and prototyping advanced production systems. It will also house the corporate mainframe computer, which holds much of the company's proprietary software, intellectual property, and financial records. The company believes that a short shutdown of the building of a few days or possibly weeks would be acceptable under a rare event, but that a major shut down of three or more months would make them consider moving their office to Austin, Texas rather than build it in a seismic zone. For truly rare events, they want to minimize but not necessarily avoid damage, but the costs of protecting their intellectual and capital investments in the building would have to be weighed against costs. Based on discussions with the owner, the design life of the structure may be assumed to be 50 years.

During the course of the semester, you will carry out a preliminary design of the structure using relatively conventional and more advanced procedures, and evaluate your design using a variety of analytical techniques. Because of the technological orientation of the client, and their active risk management program, this project allows for a lot of latitude in design. The building we will base our starting design upon was initially designed using the 1994 UBC, but now would need to be designed considering the 2003 CBC (equivalent to the 1997 UBC) as the minimum design requirements. We can use more stringent requirements to meet the owner's needs. In this class, we will use FEMA 356 (ASCE 41-06) to evaluate and improve the performance of the structure to satisfy the owner's special requirements. Some information is available about the 1994 design and

this will be provided throughout the semester, as required. However, you will see that code provisions have changed quite dramatically in the last decade, resulting in more than a doubling of the expected design forces. As such, some creativity is required in achieving an economical as well as safe structure. We will examine how to do this in these problem assignments.

It will be assumed that the structure will be constructed from steel, and initially that it will be a moment-resisting frame. Other lateral load systems will be considered later (e.g., braced frames). If you are more comfortable using reinforced concrete, this would be acceptable. However, certain information (floor weights, etc.) will be specified for steel, and homework solutions will be worked out only for steel.

Basic Description of the Building

In addition to the information provided above, consider the following for the building. Additional information will be supplied later.

Building Footprint:	120 ft by 180 ft
Building height:	3 stories; no basement; plus small penthouse 30 ft by 60 ft. in plan.
Story height:	13 ft - 6 in. typical, including the penthouse
Column layout:	a basic 30-ft grid in both directions is considered
Structural System:	Special "ductile" moment frame in steel (see above comments and figures provided below)
Building weights:	<p>Steel framing - as designed, but consider 10 psf as a reasonable Estimate since the structure needs to be redesigned.</p> <p>Decking - 3" metal decking with an additional 3-1/4 inch thick NWC fill.</p> <p>Roofing - 7 psf average</p> <p>Ceiling - 3 psf</p> <p>Flooring - 3 psf</p> <p>Mechanical and Electrical - 7 psf on all floors, 50 psf average on floor within penthouse</p> <p>Partitions - 10 psf for seismic weight calculations, 20 psf for gravity load design</p> <p>Exterior cladding - Assume 25 psf of wall surface area on average for the entire building, including the penthouse.</p> <p>Live loads - use UBC provisions for office occupancies - 50 psf (area reduction factors are permitted)</p>

Based on these values, it has been estimated that the total weights of each floor are as follows (these values can be used in subsequent calculations of lateral loads and dynamic properties). The weight of the penthouse is included in the roof values given below.

Floor	Dead Load (kips)	Live Load (kips)
Roof	1940	440
3	2370	1080
2	2370	1080

Soil Conditions: stiff soil corresponding to FEMA 368/356 class D sites
 Foundations: Spread reinforced concrete footings with allowable stresses of:
 DL = 4 ksf
 DL+LL = 6 ksf
 DL+LL+E = 8 ksf

