University of California at Berkeley
Civil and Environmental Engineering

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Spring Semester 2008

CEE 227 – Earthquake Resistant Design

Finding Seismic Design Maps, Information on Seismic Hazard and Ground Motions on the Web

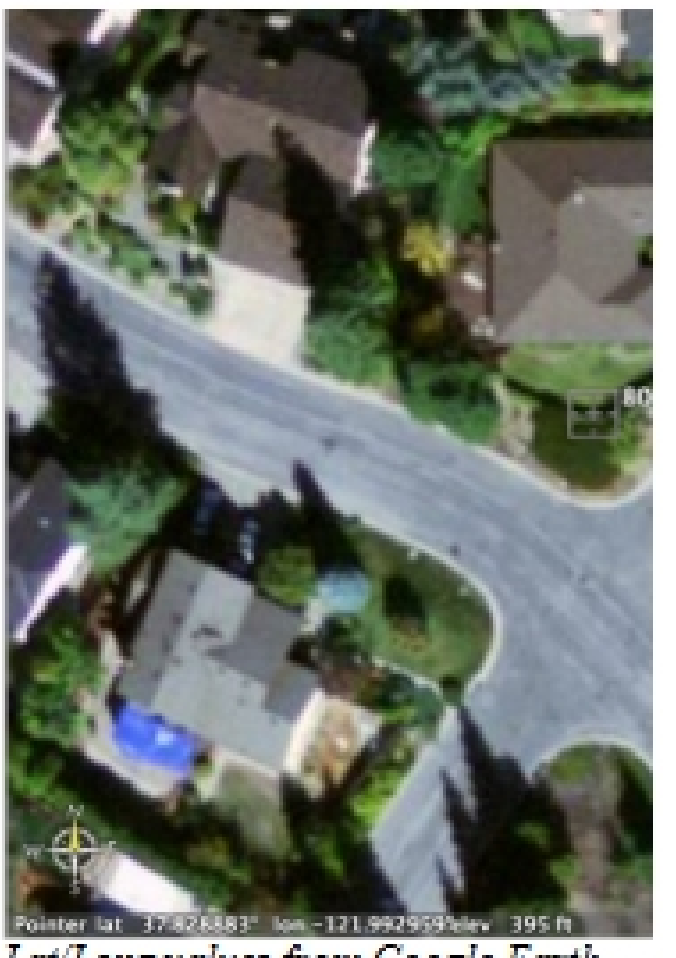
There are several useful sources of information on the web related to the likely intensity of earthquake ground motions at a particular location in the U.S. These include some powerful tools that are starting to be developed at **http://www.opensha.org/** . In addition, there are many practical tools for design and research purposes at:

http://earthquake.usgs.gov/research/hazmaps/

The USGS site includes probabilistic "Seismic Hazard Maps," "Seismic Design Values for Buildings" (i.e., plots of S_s and S_1 as used by various building codes), and some "Custom Mapping and Analysis Tools," along with background information and links related to seismic hazard analysis.

Getting started: Finding Latitudes and Longitudes

Some of the tools on the USGS and similar sites allow you to look up a site by its zip code. This is not particularly accurate in the vicinity of major faults, and these "hazard by zip code" look-ups are generally limited to hazard maps constructed in or before 1996. For other tools, especially ones based on the more recent 2002, 2003 and 2007 maps, you need to have the latitude and longitude for the site of interest. Many internet mapping utilities previously gave you the latitude and longitude of a site when you looked up an address, but this feature is no longer supported or is hidden by most (though some will locate a site if you give them the latitude and longitude). Perhaps the best and certainly most fun way of finding the latitude and longitude is using *Google Earth*. You can type in the street address, or move a cursor to a spot on a map or satellite view and it will give you the lat/long values for the site (see the lower left hand corner of satellite image window). My house is shown in Google Earth in the figure to the right, along with the lat. and long. values.



Lat/Long values from Google Earth

To get the free application Google Earth, see: **http://earth.google.com/** Note that the USGS site wants the lat/long values in decimal degrees, so by

going to the preference window in Google Earth and clicking degrees instead of degrees, minutes and seconds, you will avoid having to make the conversions manually. Note also that the USGS site only takes numerical input, so latitude in the northern hemisphere is a positive value (no N for north), and a longitude for the US is a negative value (not W for west).

Note also that there is are plug-ins for Google Earth that will plot all of the earthquakes in the world over a certain magnitude that have occurred within a specified time window, as well as show earthquake faults.

If you do not have a computer where you can access or load Google Earth, try one of these sites:

http://www.census.gov/cgi-bin/gazetteer
http://www.melissadata.com/lookups/addressverify.asp

Seismic Hazard Maps

Looking at the "Seismic Hazard Map" link on the USGS site, you will see information for the 48 conterminous states, Alaska, Hawaii, and a few other places in the world. Clicking on "48 Conterminous States" gives you a page with three columns; one referring to 2007 (Preliminary) Documentation, 2002 Documentation and Data, and the other referring to 1996 Documentation. The buttons that say *Maps* will give you large static maps in .pdf or other formats. You have to have really good eyes to make much use of these maps for design.

If you look lower down on the page, you get a series of links under the heading "Hazard Values." The first link "Gridded Values" just downloads a big file of hazard values tabulated at a 0.05 degree latitude and longitude grid spacing across the country. This is useful if you are writing your own program.

The next link, "Hazard by Lat/Long" is more useful. By typing in the latitude and longitude values for the site of interest you get a small table like that shown below, which gives the hazard in terms of PGA, $S_{0.2}$ and $S_{1.0}$ corresponding to 10% and 2% probabilities of exceedence in 50 years. From this you can use the methods described in class (or FEMA 450, etc.) to construct a smoothed elastic response spectrum corresponding to these and other hazard levels.

LOCATION 37.828670 Lat. -121.992616 Long.
The interpolated Probabilistic ground motion values, in %g,
at the requested point are:

	10%PE in 50 yr	2%PE in 50 yr
PGA	71.26	116.43
0.2 sec SA	167.21	285.41
1.0 sec SA	60.39	106.61

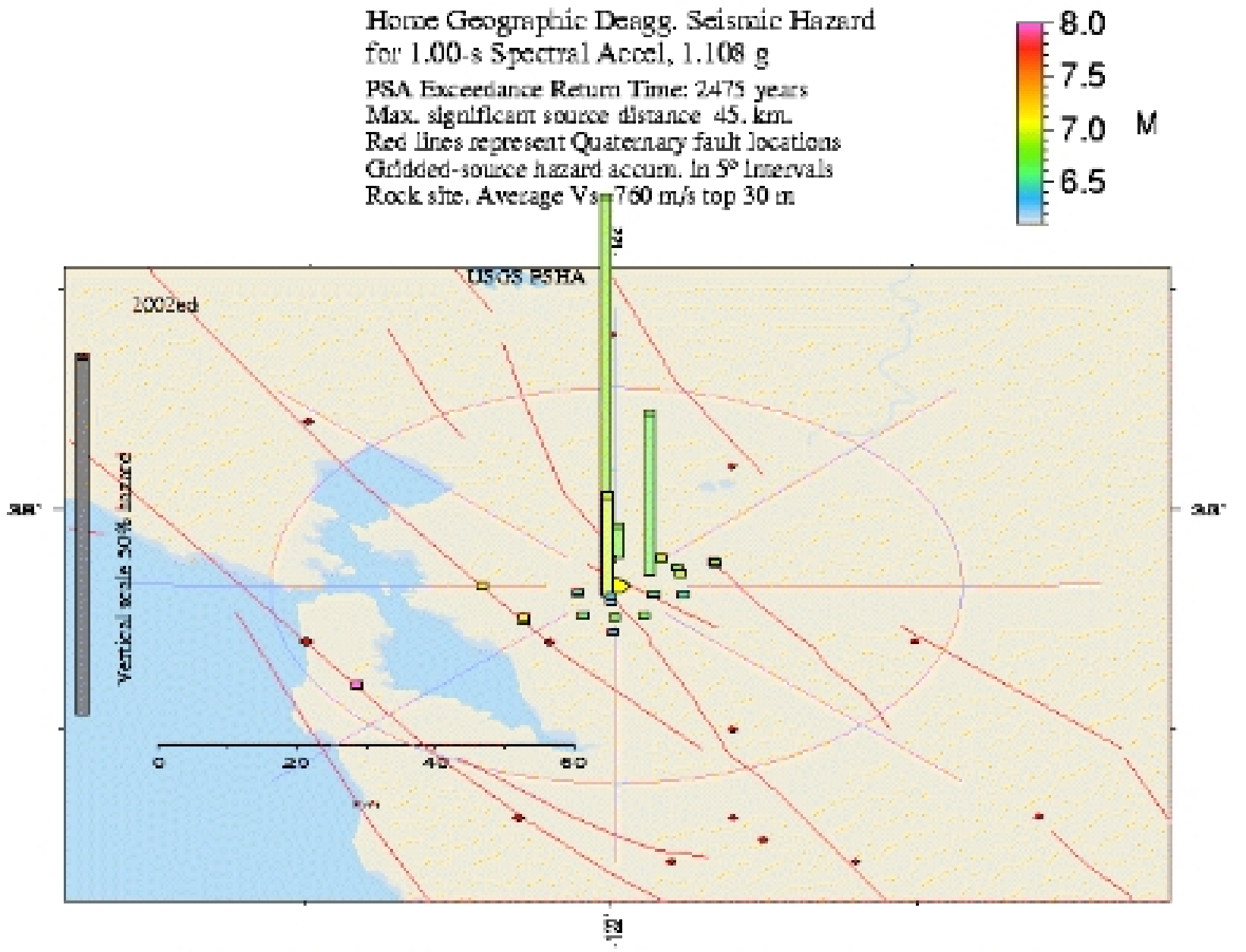
SEISMIC HAZARD: Hazard by Lat/Lon, 2002

Table of Seismic Hazard from USGS site for Specific Lat/Long

Interactive Deaggregation -- What kind of earthquakes contribute to the hazard at a site?

By clicking on the link "Interactive Deaggregation" you can see a small map of the vicinity surrounding the site. You can put in different frequencies of interest (say a period of 1 second), and what IM you are interested in (PGA, Sa, etc) for a given hazard level, and find out what types of earthquakes contribute to the hazard level at the site.

For the site in the above example, you can get two types of plots. The first of these is a "Seismic Hazard Map" which shows a map with the earthquake events considered in the hazard analysis and their contribution to the overall hazard. For the site being considered, considering PSa at T = 1sec, and a 2% probability of exceedence, we get the following map. The site is near the intersection of three faults (Calaveras, Greenville, Concord), and the hazard is dominated by a magnitude 6.5-7.0 event on the near by Calaveras fault. For this hazard level and site, the Hayward fault contributes negligibly to the seismic hazard.



Seismic Hazard Map from Interactive Deaggregation Feature

More quantitative information is obtained from the "Hazard Graph" link on the Interactive Deaggregation report. This is shown below for the site being examined here. We can see that the hazard is dominated by earthquakes at a distance about 3 km away, with a much smaller contribution from another fault about 4 km away (in the other direction as can be seen from the Seismic Hazard Map shown above). There are