Assignment 7: "Recorded Earthquake Motion Databases (Libraries)"

Examples of such databases include The COSMOS Virtual Data Center

http://db.cosmos-eq.org/

http://db.cosmos-eq.org/scripts/search.plx

We are going to use the database of the Pacific Center for Earthquake Engineering (PEER) http://peer.berkeley.edu/smcat/

Please keep on referring (as you need) to the documentation page of this database at

http://peer.berkeley.edu/smcat/documentation.html

Note: Please also note that at this website: PGA = Peak ground acceleration, PGV = peak ground velocity, PGD = peak ground displacement.

Question No. 1

Go to http://peer.berkeley.edu/smcat/search.html and search for Imperial Valley 1979/10/15 23:16 earthquake (select this record from "Earthquake"). Choose a record with closest distance less than 15 km (from "Distance (km)" put 0 and 15). Choose a **free-field** record (from "Instrument Housing" select free filed instrument or instrument shelter). Search for peak ground acceleration greater than 0.1 g (from "PGA (g)" select 0.1 as the low range and leave the other blank). Look at the search results and select any one of the horizontal ground response records (a record that does not show up or down under the "Record/Component" column, since these denote the vertical shaking component). The 3 components of the station (recording location) you chose will appear anyway. For each component you will find acceleration, velocity and

displacement time histories (note that velocity and displacement records are derived from the recorded acceleration motion by integration and "Doctoring" in an attempt to remedy deficiencies arising from inevitable possibly really minute errors in the original recorded acceleration motion). You will also find the corresponding spectra (calculated already) for several damping ratios.

Go ahead and open the acceleration time history file. Check the first few lines for information (this section of the file is known as the "Header"). Below the Header, you will find the values of recorded acceleration (arranged five per row in this database). Highlight all rows and select copy. Paste the data in a MS Word file and do the following to change this data to a single column format in order to plot using Excel:

Click Word menu: Edit --> Replace
In the pop up dialogue, do the following,
Find what: ^w
Replace with: ^l
(note: above l is lower case letter L)
Click on Replace All
After this step, you will see that the file has one column of data, but with
some extra blank lines. To remove these blank lines, you need to do "Replace" operation again.
Find what: ^p^l
Replace with: ^l
Click on Replace All

Now you have a single column of acceleration points in units of (g). Copy and paste in Excel (the number of rows should match NPTS = …. in the Header information, which is the number of points). Create another column for time in seconds (using the time step of DT= .00500 SEC for instance from the Header information at the top of the website file). The first time entry is 0.0 and time increases by DT.

Now go ahead and save your excel file (use file name to remind you which file you've downloaded). Use Excel to plot this file, and make titles using the Header information in the website file (e.g., "ANZA 02/25/80 1047, ANZA FIRE STATION, 225"). Make sure the X and Y axes have appropriate labels (e.g., on the vertical axis, Acc. (g) and on the horizontal axis, Time (sec.)).

You might want to plot an additional figure of this acceleration history in units of m/ses/sec (hint: create a new column of acc. and use it, where all "g" acc. values are multiplied by 9.81). Make sure the vertical axis label shows the correct units.

SPECTRA

Now its time to look at Spectra. Go back to the webpage where histories and spectra are accessible. Under the Spectra column, click on 5% (this is the damping ratio used to generate this particular set of Spectra for the particular ground motion record you're looking at). An example of the Header information in such a file follows:

PEER STRONG MOTION DATABASE SPECTRUM. PROCESSING BY PACIFIC ENGINEERING.
ANZA 02/25/80 1047, ANZA FIRE STATION, UP (USGS STATION 5160)
FILTER POINTS: HP=0.5 Hz LP=30.0 Hz
NO FREQ=112,DAMP=.050: FREQ NO,FREQ,RD,RV,PRV,AA,PAA,MAG RAT,PER

(See also "Documentation" under "Data Files" for information related to the section below)

In this file you have columns of Spectral information. The first column is row number (FREQ NO). The second is Frequency value in Hz (this will be one of the axes in a spectral plot, and this column can also be converted in another column later to Period in seconds which is 1.0 / (Freq in Hz), or into radians omega = 2 Pi FREQ if you wish). Then comes a column of RD (relative displacement or Sd or D, which can be the vertical axis in a Relative Displacement Spectrum plot), then RV (which is spectrum of peak relative velocity), then PRV (which is the Sv or V or the Pseudo velocity Spectral values equal to omega Sd), then AA (which is the actual absolute

acceleration spectral value), then PAA (which is the Pseudo acceleration spectral value or Sa or A = omega squared Sd = omega Sv), then Mag Rat (normalized acceleration spectrum with respect to the peak input acceleration), then PER which is Period in seconds (equal to 1.0 / FREQ). You might be interested in making an Excel file out of the Spectrum file that you're looking at. In order to do that (**this is not required as part of this Homework**):

1) highlight and copy the response spectrum data (only the numbers) from web browser.
2) open the NOTEPAD file, paste your data, and save it as a Text Document.
3) Run the Microsoft Excel program and open your saved file using the Excel Menu (File -- > Open)
4) In the Text Import Wizard - Step 1 of 3 window, do the following:
check Fixed width radio button
put 1 in the field of Start import at row.
click on Finish
Then you will see the data organized by columns in Excel free of any special characters. Save the Excel file under a name that reminds you of the record name you're looking at. Now, you can plot using excel anything such as Sd or Sv or Sa versus Period if you wish.

Question No. 2

In order to develop a sample Elastic Design Spectrum, we decided to select records for the following search scenario (e.g., representative of some geographic location of interest):

Earthquake: Any
Mechanism: Strike-Slip
Magnitude range 6
Distance 0 –15
Instrument location: Free Field
Data Source: Any
PGA 0.4

Upon clicking search, you will get 10 records (horizontal shaking), from Imperial Valley 1979, Morgan Hill 1984, and Parkfield 1966 earthquakes. The Pseudo acceleration spectra and period for these 10 events (all at 5% damping ratio) are included in the provided Excel file. Using this file:

2a) Create new columns in which we have normalized spectral shapes with respect to the peak ground acceleration in each record (this would be the acceleration value corresponding to the

highest available frequency (or least value of Period) in each case, since this would be the "Stiff structure" that moves rigidly with the ground).

2b) Using the normalized spectra columns, plot all 10 records on one plot to see the variation (do not forget to label the axes, and use Period in seconds for your X axis).

2c) Using Excel functions, calculate and plot average and average + 1 sigma and average + 2 sigma and comment.

2d) Compare to the Elastic Design Spectrum shape in the notes (see page 20 of handout).