U.S. NATIONAL CENTER FOR ENGINEERING STRONG MOTION DATA (NCESMD)

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Abstract

The U.S. Geological Survey (USGS) and the California Geological Survey (CGS) have established a cooperative U.S. National Center for Engineering Strong Motion Data (NCESMD), which will have mirrored operational centers in Sacramento and Menlo Park, CA. The National Center integrates earthquake strong-motion data from the CGS California Strong Motion Instrumentation Program, the USGS National Strong Motion Project, and the regional networks of the USGS Advanced National Seismic System (ANSS), thus serving as a provider of uniformly processed strong-motion data for seismic engineering applications. The NCESMD builds on the Engineering Data Center of the California Integrated Seismic Network, and so will continue to serve the California region while expanding to serve other ANSS regions. The National Center will assimilate the Virtual Data Center, which was developed at U.C. Santa Barbara with support from the Consortium of Strong Motion Observation System (COSMOS), NSF and SCEC. A Center Management Group with input from an external Advisory Committee manages the NCESMD. Products will be generated by both CGS and USGS facilities, thus ensuring robustness. Each ANSS region is responsible and credited for the data recorded by its regional network. The National Center is co-hosted by CGS and USGS at www.strongmotioncenter.org.

Introduction

The U.S. National Center for Engineering Strong Motion Data was recently established as a single, unified facility to provide earthquake strong motion data for engineering applications. The goal of the Center is to provide timely, quality-controlled, and easily accessible data for domestic and foreign earthquakes of engineering interest. The Center is responsible for receiving data from field stations, uniformly processing data, rapidly releasing data through the web site, and archiving data. It also provides a search engine to facilitate selection of data from its archive. The National Center evolved from the TriNet Engineering Strong Motion Data Center (Shakal and Scrivner, 2000; Shakal et al, 2002) and the California Integrated Seismic Network Engineering Data Center (CISN EDC) (Shakal et al, 2003; Huang et al, 2004), and includes the California strong motion data of the CISN EDC as well as that of the other ANSS regions of the US. This paper describes the National Center's web site, its available functions, and plan for further developments.

National Center Web Site

The National Center web site, hosted by CGS at http://www.strongmotioncenter.org, consists of three major sections: Internet Quick Reports (IQR), Internet Data Reports (IDR), and the Search Engine. Figure 1 shows the home page of the National Center. In addition to serving as a data source, the National Center will also notify users when important new data are available, and when important pages are updated.

The NCESMD web site has removed some of the limitations of the CISN EDC site. The NCESMD's web site is a dynamic web site in which all the web pages are generated on-the-fly. Data are retrieved from a database in real time when users open web pages. The dynamic nature of the database-driven system makes it much easier to ensure that tables and maps will always contain updated data.

The Internet Quick Reports

The National Center, like its predecessor CISN EDC, continues to provide the most current strong motion data of engineering significance through the Internet Quick Reports (IQR) that are generated after earthquakes. The Internet Quick Reports are intended primarily for post-earthquake response and analyses. The first version of the IQR is usually released within a short time (the goal is less than 30 minutes) after the event. This early version may not include all the records, and more complete IQR pages are posted as data are recovered and received by the National Center. The National Center plans to automate preliminary data processing and dissemination in the near future, which will make the information available more rapidly. A snapshot of an IQR event summary page is shown in Figure 2. The user can access the Internet Quick Report for individual events by clicking on the event name on the event summary page. For example, Figure 3 shows the individual event page that is displayed by clicking on the table entry for the Chatsworth earthquake that occurred on August 9, 2007, in California.

The main feature of the IQR page for each event (e.g., Figure 3) is a table summarizing key information about the record at each station, including epicentral distance (and distance to the causative fault, if available), peak ground acceleration, velocity, and displacement, and spectral acceleration values at periods of 0.3, 1.0, and 3.0 seconds. Immediately above the table are three icons: the Earthquake Info icon on the left provides information about the location and mechanism of the earthquake; the ShakeMap icon on the right links to the corresponding ShakeMap generated by an authoritative agency; and the center icon links to an Interactive Map of strong motion stations, a new feature that is described in more detail below.

The IQR tables are now generated dynamically, which allows the entries to be sorted by station name, station number or ID, network, epicentral distance, and peak ground accelerations of the records (Figure 3).

Records from individual stations can be viewed and downloaded from the IQR page by clicking on the buttons in the appropriate columns to the right. Figure 4 shows an example of

the acceleration and displacement time histories and also response spectral accelerations for a two-story office building.

Station information is accessible by clicking on the name in the Station column of the IQR table. Figure 5 shows an example of the station information page. For structures, information about the floor plan and foundation type is provided in the station information page. The sensor layout, which shows locations of the sensors in the structure, is provided in PDF format and can be downloaded by clicking on the sensor layout image on the upper right side of the station information page. Figure 6 shows the sensor layout of the Chatsworth – 2-story Commercial Building as an example.

Interactive Map

A new feature has been developed for the National Center web site that allows users to view a map of strong motion stations in addition to the standard text table format. This feature makes use of the Google Maps® web service (http://www.google.com/apis/maps).

An example of the map interface for an IQR page is shown in Figure 7. The map shows the earthquake epicenter and the stations that recorded the earthquake. The station symbols (circles for ground sites, squares for structures) are colored according to maximum horizontal acceleration (PGA), so a user can see at a glance where the highest ground motions were recorded. The corresponding legend of PGA values appears in the upper right corner of the map. For consistency, the colors used in the symbols correspond to the intensity coloring used on ShakeMaps for that acceleration. Many standard features of Google Maps® are also present. For example, the inset at the lower right corner of the map provides regional context, a scale bar is displayed at the lower left corner of the map, standard navigation tools (zoom, translation) appear in the upper left of the map, and the base map view (Map, Satellite, Hybrid) can be selected at the upper right. These features allow the user to interactively drag or pan the map around using either the left mouse button (click and drag), or the arrows at the upper left corner of the map. The button in the middle of those arrows (the one with four arrows pointing inward) will bring the user back to the previous map coverage. The map can also be panned by clicking and dragging the blue rectangle inside the regional overview map.

When the mouse hovers over a station on the map, a photo of the station appears beside the map to the lower right, along with some information about the station. The user can also click on the station to open a pop-up window containing basic information about the station and links to the station's time history, station page, and strong motion data. Clicking on the epicenter opens a pop-up window providing the basic information on the earthquake. Once an information window has been opened, it can be closed by using the "X" button in its upper right corner, or by clicking anywhere on the map background.

A feature has been added in the Interactive Map that allows users to download a file with station information in KML format so that it can be viewed in three dimensions in the Google Earth® viewer (http://earth.google.com). In contrast to the 2-dimensional Google Maps viewer, which can be incorporated within an organization's web site, Google Earth is a standalone 3-D geospatial exploration system that a user must download from Google and install locally.

Internet Data Reports

While the IQR is used to provide strong motion records of the most recent earthquakes, archived records are available in the Internet Data Reports (IDR). The IDR pages are sorted by event date (most recent on top). The layout of the IDR pages is the same as that of the IQR pages, so a user who is familiar with the IQR will find it easy to use the IDR pages. Figure 8 shows the front page of the Internet Data Reports.

Concurrent with the accumulation of data from new and recent events, the NCESMD also will be adding significant historic records to the to the IDR archive.

Search for Data

Strong motion records of the National Center are searchable using the "Search for Data" button on the National Center's front page. Clicking on this button will display the search page shown in Figure 9, which currently includes two search options, one for the NCESMD and one for the COSMOS Virtual Data Center (VDC). Currently these two options are needed because both the extent and scope of data holdings and search options of these two data centers are incongruent (presently the VDC provides access to worldwide and historical US data not yet available through the NCESMD). Eventually, however, the National Center will incorporate the Virtual Data Center (VDC) so that users will then be able to access US and significant international data through the NCESMD web site.

The current search engine of the NCESMD for US structural and ground response data is shown in Figure 10. The records in the NCESMD archive are searchable in several ways, depending upon a user's interests. In general, the search parameters can be a combination of earthquake, station, and record parameters. The searchable earthquake parameters are earthquake name, magnitude and date. The station parameters are station city, station name, number, and type. The station type parameters are ground stations, buildings, bridges, dams, geotechnical arrays, and other station types that are not specified. For building stations, additional search parameters include material (such as wood, steel, concrete, masonry), whether or not there is base-isolation, and height (low, mid, and high rise). An example of a search result is shown in Figure 11. The search table can be sorted the same way as an IQR or IDR table. The search table is linked to the station pages and to the corresponding IDR pages. The records are also directly viewable and dowloadable from the search result table.

Future Developments

The National Center is currently engaged in the process of transitioning the Virtual Data Center (VDC) to the National Center to provide all users with a better and more convenient one-stop portal to both US and significant international strong motion data. Concurrently, the NCESMD is working to implement modifications and enhancements to existing search options and display features in response to suggestions from an external Advisory Committee, and also working to implement automatic data collection and preliminary processing and dissemination. The goal is to provide at least preliminary versions of US strong motion data through the

National Center within a few minutes after a significant event and fully vetted data soon afterwards. The records from all ANSS strong motion networks will be uniformly processed and provided in the COSMOS format. The National Center will notify registered users when important new pages are posted and/or when an existing page is significantly updated.

Summary

- The National Center for Engineering Strong Motion Data, NCESMD, is a cooperative effort of the California Geological Survey and the US Geological Survey to establish a unified strong motion data center for engineering applications. The National Center integrates earthquake strong-motion data from the CGS California Strong Motion Instrumentation Program, the USGS National Strong Motion Project, and the regional networks of the USGS Advanced National Seismic System (ANSS).

- A Center Management Group manages the NCESMD with guidance from an external Advisory Committee.

- Products will be generated by both CGS and USGS facilities, thus ensuring robustness. Each ANSS region is responsible for and credited for the data recorded by its regional network.

- The National Center is working to incorporate the COSMOS Virtual Data Center to provide one-stop convenient and effective access to US and significant international strong motion data.

- The web portal of the National Center has evolved from the CISN EDC site. It is now a database-driven site with dynamic pages and new map features that facilitate the use of strong-motion data.

Acknowledgements

The Google Map® feature of the National Center was implemented by Peter Roffers with the assistance of Jessica Zhang. The efforts of Jessica Zhang in adopting a database for the National Center and designing the new dynamic web pages are acknowledged. We would also like to acknowledge the National Center advisory committee and others for their input and advice on improving the functionality and effectiveness of the National Center.

References

Shakal, A. and C. Scrivner (2000). TriNet Engineering Strong-Motion Data Center, *Proceedings of SMIP2000 Seminar on Utilization of Strong-Motion Data*, p. 115-124.

Lin, Kuo-wan, A. Shakal, M. Huang, C. Stephens and W. Savage (2002). Dissemination of Strong-Motion Data Via the Internet Quick Report and the Internet Data Report at the CISN Engineering Data Center, *Proceedings of SMIP2002 Seminar on Utilization of Strong-Motion Data*, p. 115-126.

Shakal, A., K. Lin, M. Huang, C. Stephens and W. Savage (2003). Rapid Post-earthquake Strong-Motion Data via Internet Quick Report and the CISN Strong Motion Data Center, *Proceedings of SEAOC 2003 Convention*, September 18-19, 2003.

Huang, M., A. Shakal, K. Lin, C. Stephens and W. Savage (2004). Rapid Post-earthquake Strong-Motion Data from the CISN Engineering Strong Motion Data Center, *Proceedings of the 13th World Conference on Earthquake Engineering*, Vancouver, B.C., Canada, August 1-6, 2004.
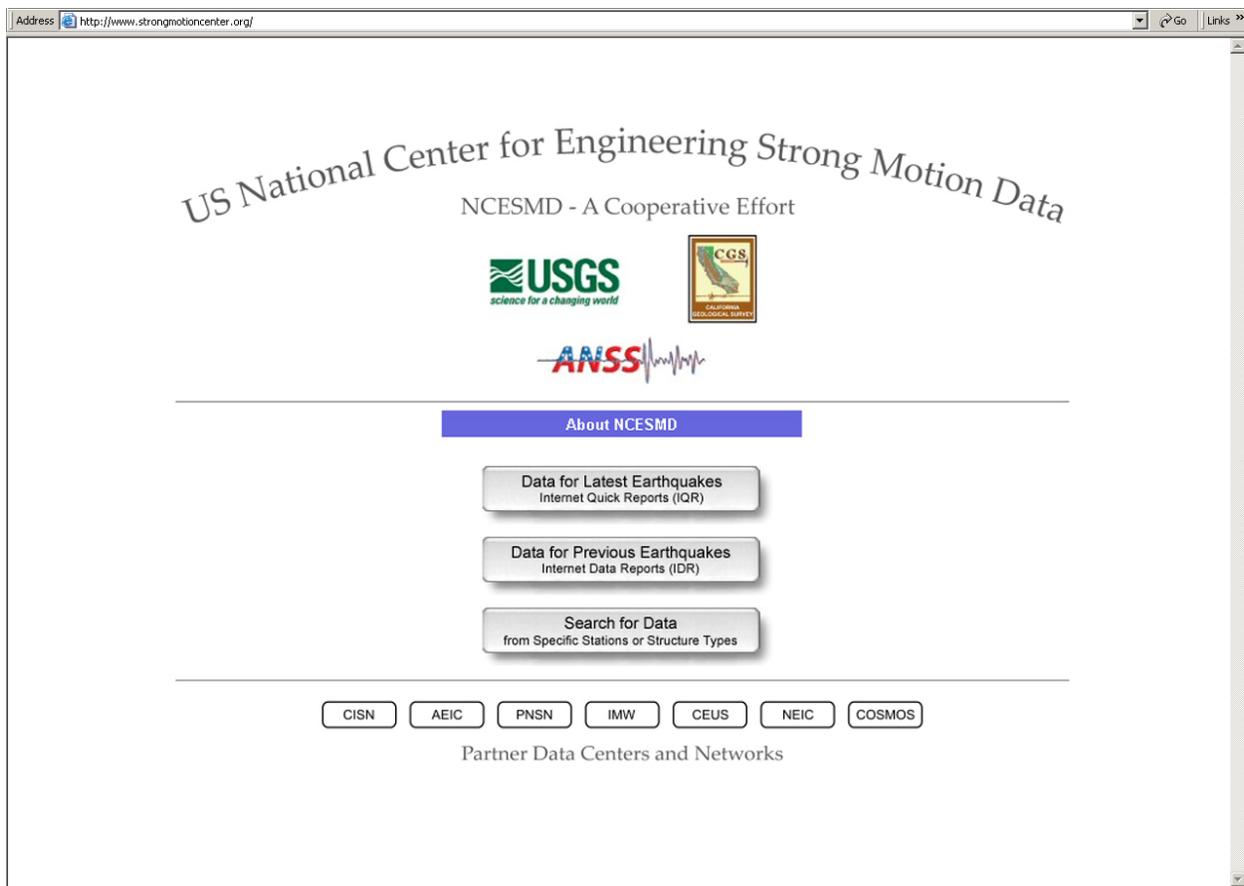
Figure 1. The home page of the National Center's web site.
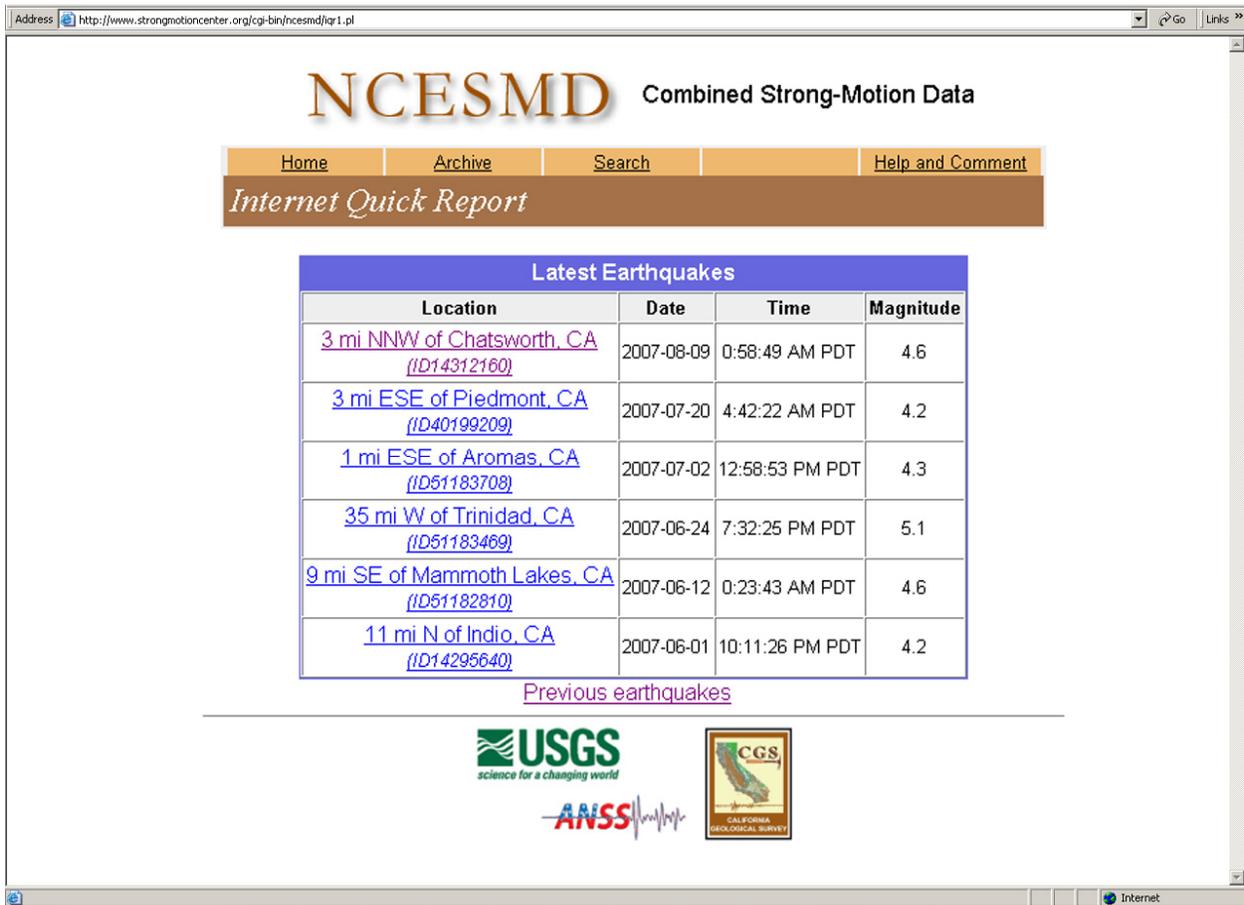
Figure 2. The Internet Quick Report summary page listing the latest earthquakes.
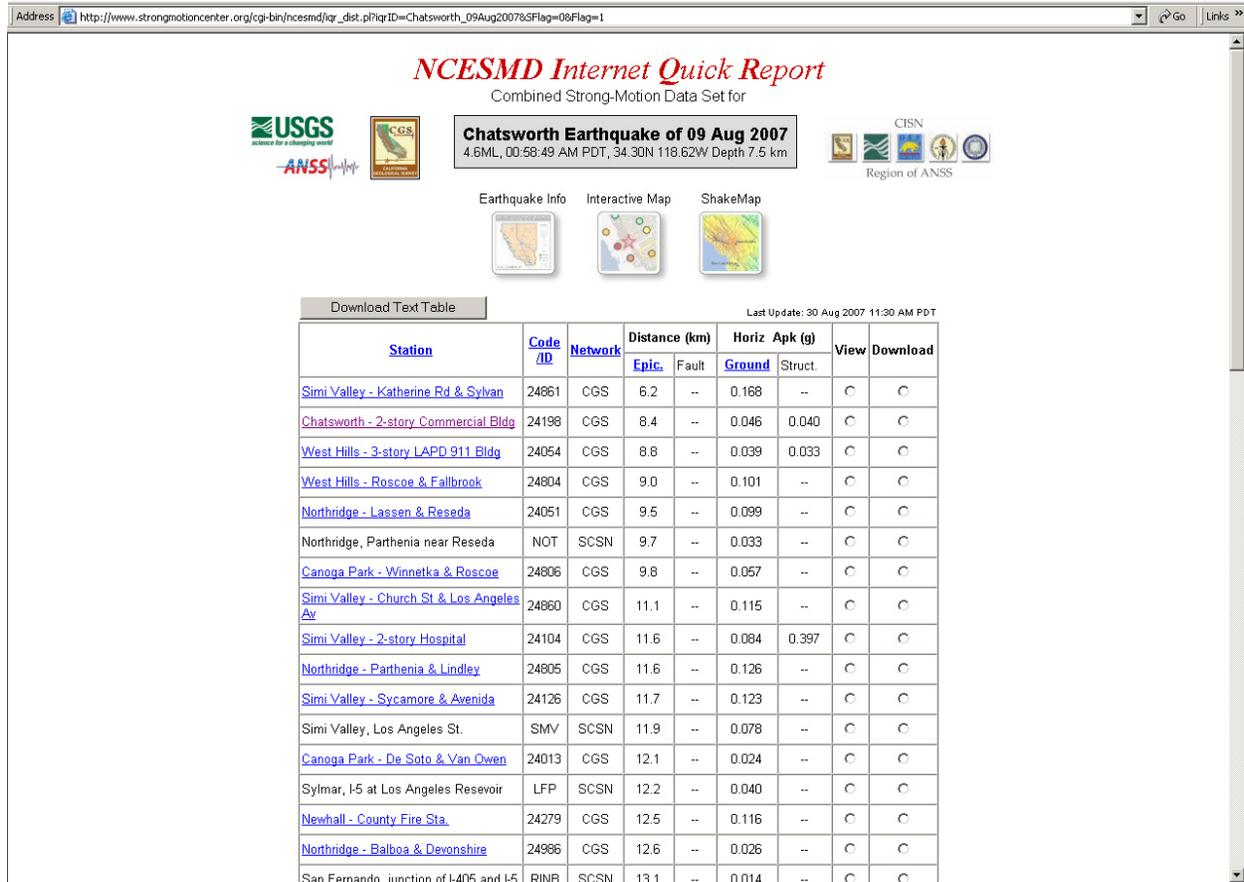
Figure 3. Internet Quick Report (IQR) table for the Chatsworth earthquake of August 9, 2007.
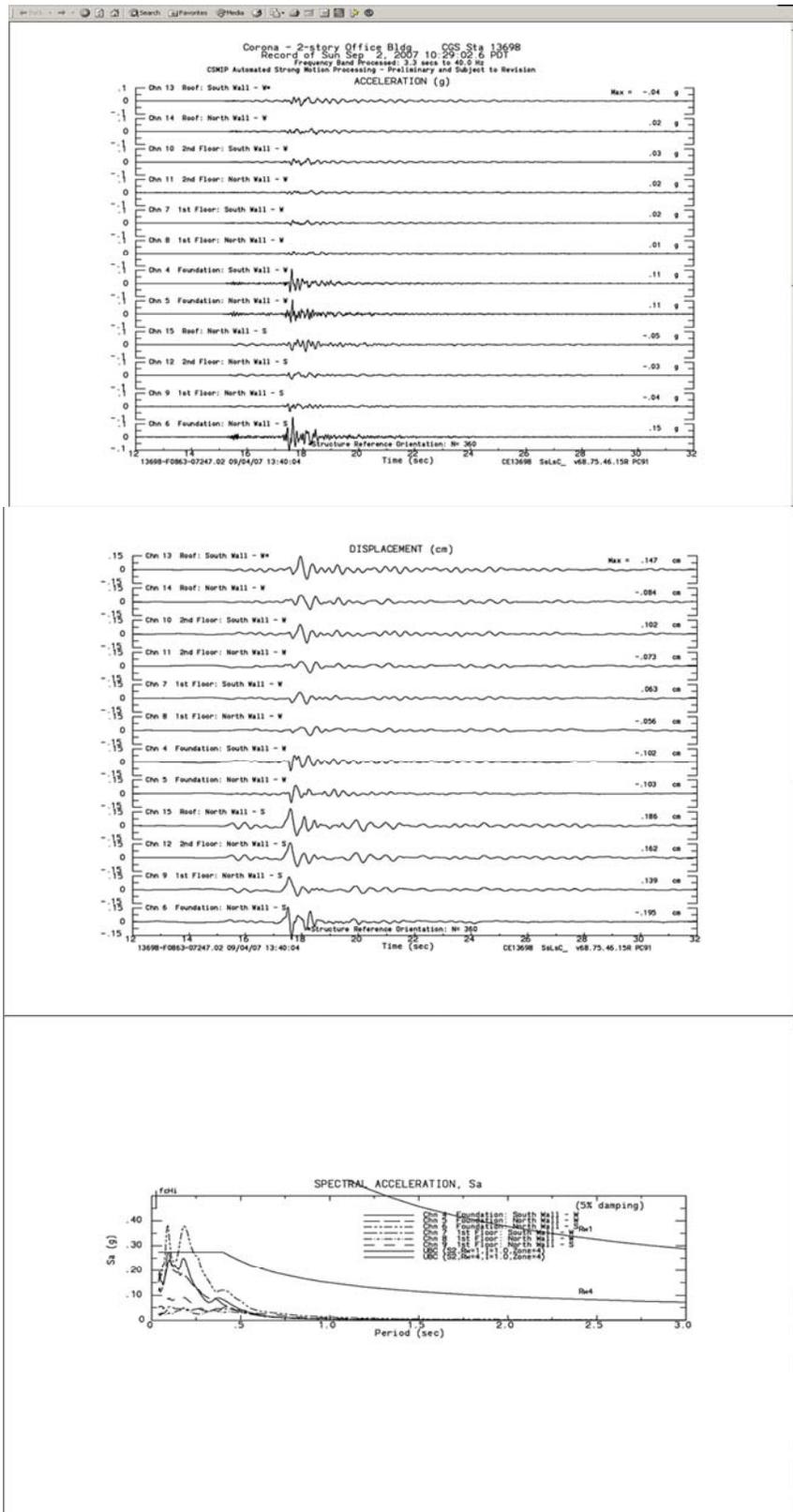
Figure 4. An example of the acceleration, displacement, and response spectral acceleration plots in the Data Center's Internet Quick Reports and Data Reports.

Figure 5. An example Station Information Page, for the Chatsworth, California, 2-story Commercial Building.
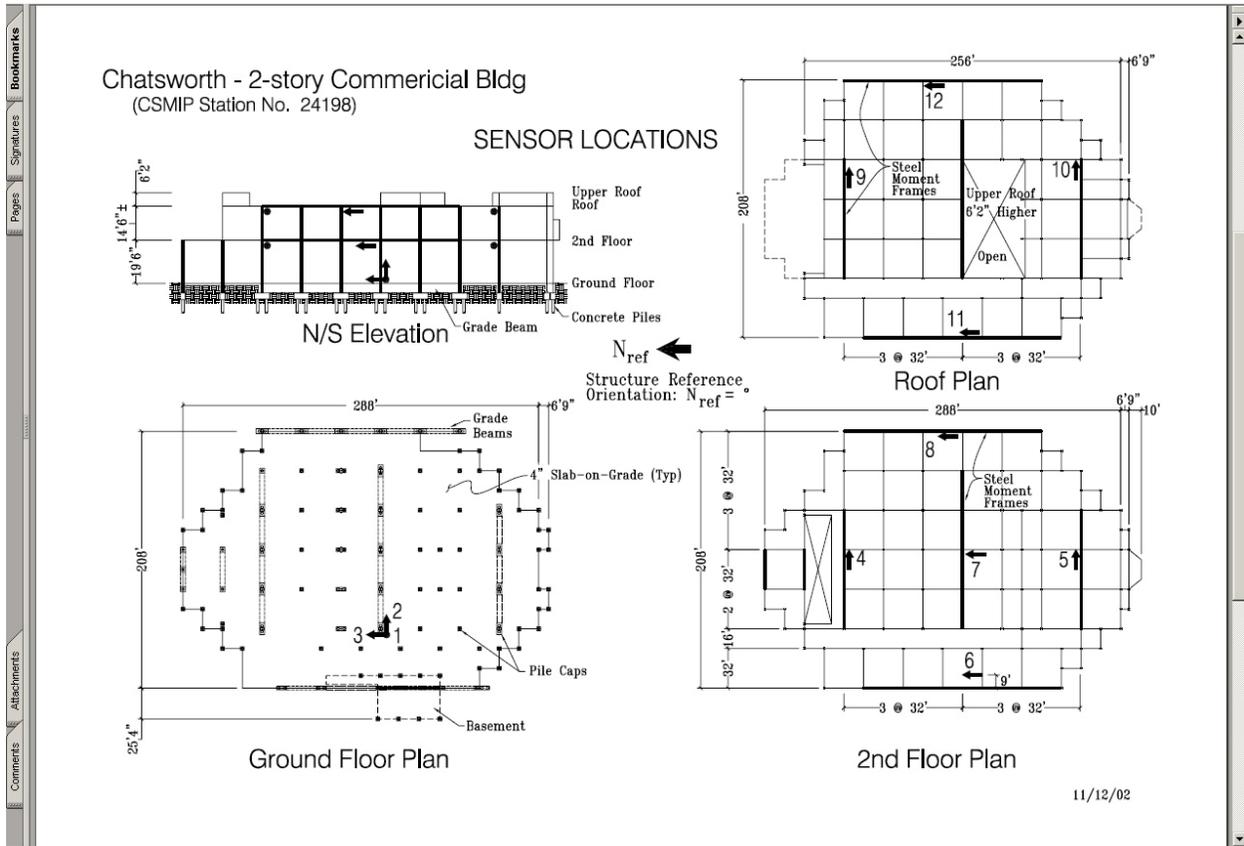
Figure 6. Sensor layout for the CGS station, Chatsworth, California, 2- story Commercial Building.

Figure 7. The IQR Interactive Map, generated for the Lafayette Earthquake of March 1, 2007.
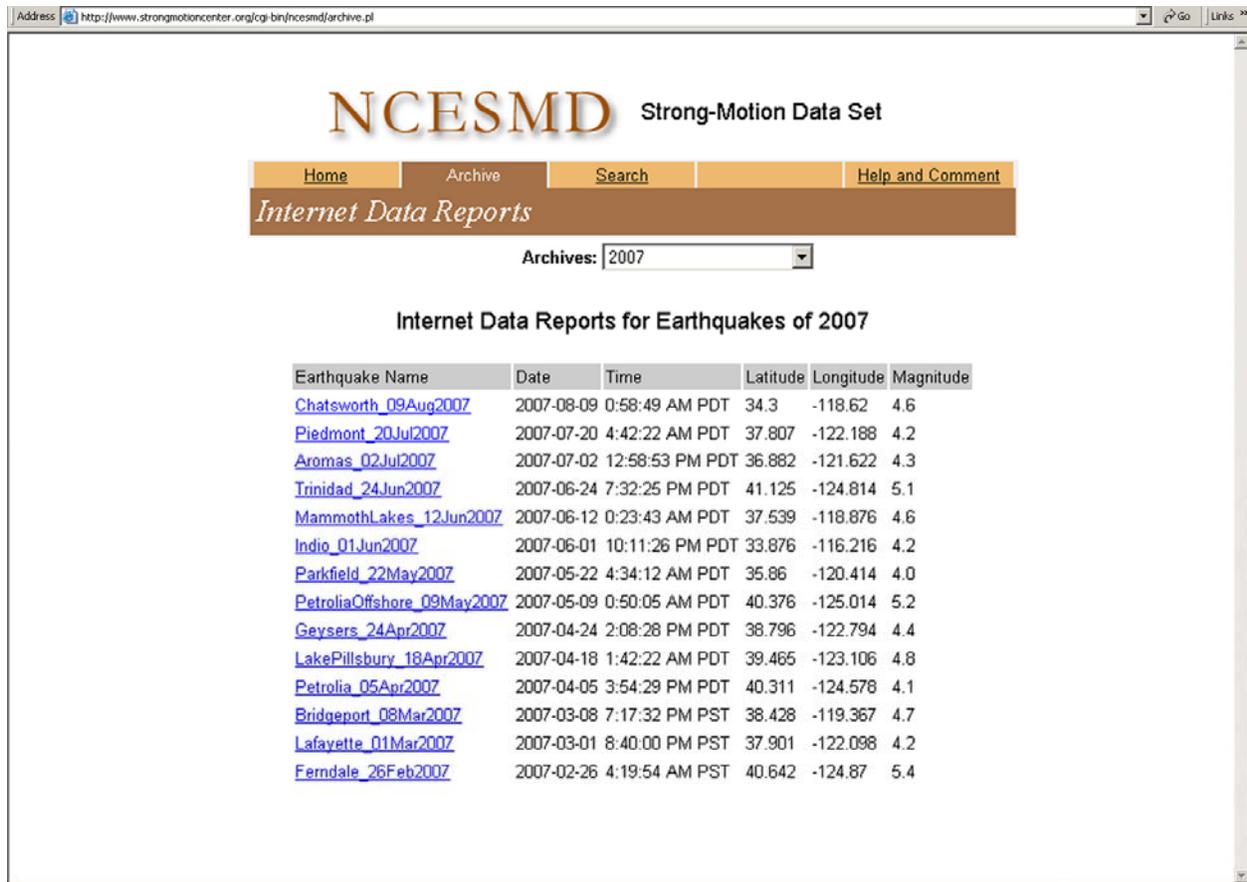
Figure 8. The Internet Data Report (IDR) page of the National Center. Data are grouped by the event year in the archive.
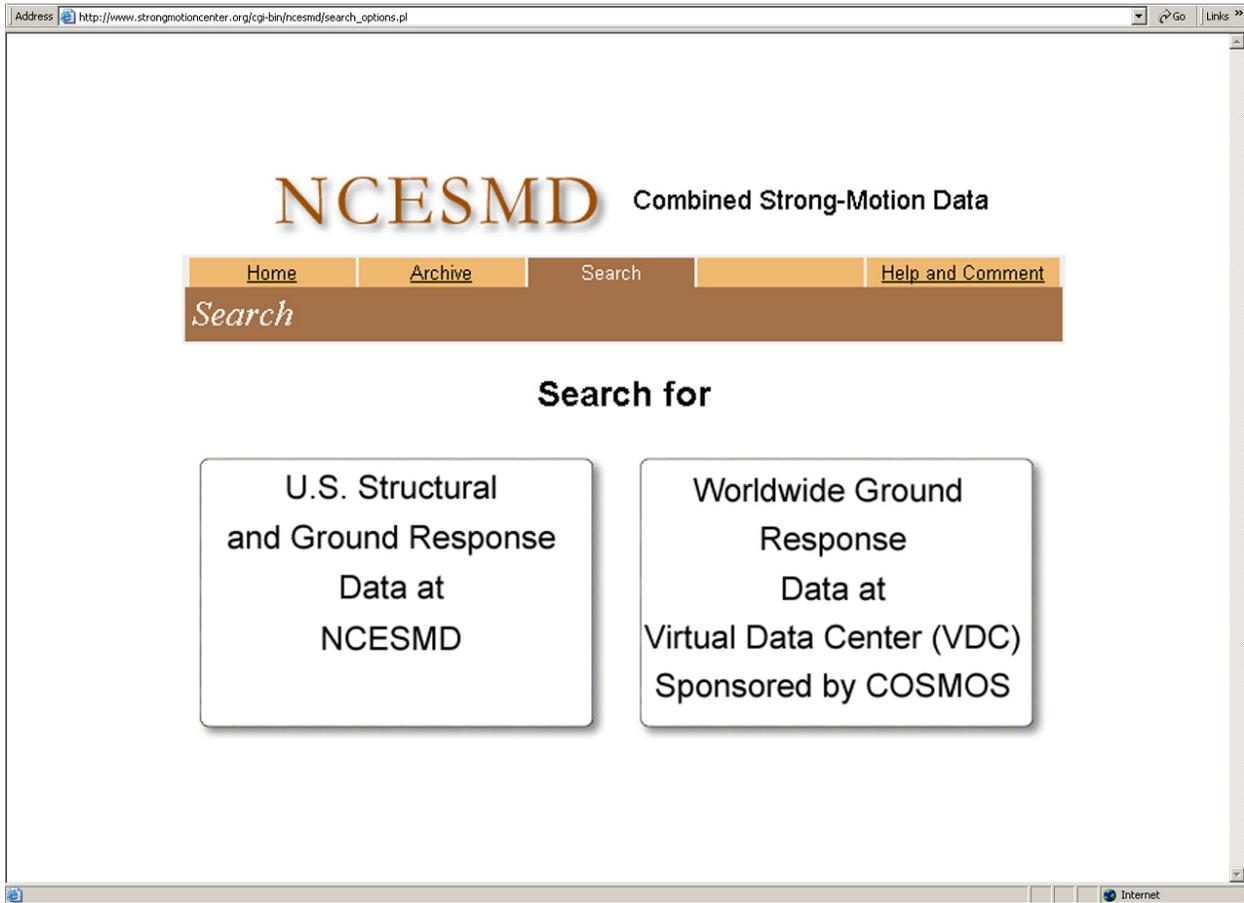
Figure 9. Search for Data in the National Center and the Virtual Data Center (VDC)'s search facility. The two functions will be integrated to provide "one-stop shopping" for earthquake strong motion data.

Figure 10. The National Center's search engine interface, showing the available search parameters.

Figure 11. The search engine results are displayed in a table that can be sorted like the IQR table. The records obtained through the search are viewable and downloadable directly, in the same way as for the IQR and IDR pages.