Center for Engineering Strong-Motion Data (CESMD)

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ABSTRACT :

The Center for Engineering Strong-Motion Data (CESMD) has been established by the U.S. Geological Survey (USGS) and the California Geological Survey (CGS) to provide a single access point for earthquake strong-motion records and station metadata from the CGS California Strong-Motion Instrumentation Program, the USGS National Engineering Strong-Motion Program, and the US Advanced National Seismic System (ANSS). The Center provides uniformly processed U.S. strong-motion data for earthquake engineering applications at www.strongmotioncenter.org. The CESMD builds on the Engineering Data Center of the California Integrated Seismic Network (CISN), and so will continue to serve the California region while expanding to serve other ANSS regions. The Center has operational centers in Sacramento and Menlo Park, California. Products are generated by both CGS and USGS facilities, thus ensuring robustness. Each strong-motion network operator is identified and receives credit for the data they have recorded. The CESMD web site provides new features to assist users in reviewing and selecting strong-motion records. Interactive Google Maps quickly displays maps and satellite views of strong-motion stations with symbols for the type of station (ground response or structural) and color coding according to PGA values. The views can be manipulated using standard tools, and can also display a photo of the station when the pointer hovers over the station symbol. The mapping tool can also display all the stations installed in an area as well as planned stations. All the stations loaded in the CESMD can be easily viewed in map form and data easily downloaded. The Center is in the process of assimilating the COSMOS Virtual Data Center, which was developed at U.C. Santa Barbara with support from the Consortium of Strong Motion Observation System (COSMOS), National Science Foundation (NSF), and the Southern California Earthquake Center (SCEC). The goal of all these developments is to continually improve access by the earthquake engineering community to strong-motion data and metadata world-wide.

KEYWORDS: strong-motion data, seismic network, acceleration time history, response spectra

1. CESMD OBJECTIVES

The U.S. Geological Survey (USGS) and California Geological Survey (CGS) have established the Center for Engineering Strong Motion Data (CESMD) 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 from domestic and international earthquakes of engineering interest. The CESMD was established by the USGS Earthquake Hazards Program and its National Engineering Strong-Motion Program (NESMP) and Advanced National Seismic System (ANSS), and the CGS Strong Motion Instrumentation Program (CSMIP). The Center is responsible for receiving US data from field stations, uniformly processing the data, rapidly releasing it through the Web, and archiving the data. In addition to strong-motion records, the Center provides information about site characteristics of stations (e.g., Vs30 and near-surface geology), and station characteristics such as structure type, height, and seismic design for instrumented structures, and a photograph showing the station surroundings.

The Center is currently engaged with the Consortium of Strong Motion Observation System (COSMOS) in the

process of transitioning the COSMOS Virtual Data Center (VDC) to integrate it with the CESMD for improved efficiency of operations and to provide all users with a more convenient one-stop portal to both US and important international strong motion data. The Center is working with COSMOS and international and US data providers to improve the completeness of site and station information, which are needed to most effectively use the recorded data.

2. CESMD OPERATION

The Center is managed by a Center Management Group (CMG), which consists of representatives from the CGS and USGS to coordinate policies and to oversee operation, coordination, and standardization of the CESMD operations. The Center Advisory Committee consists of researchers and practitioners from the engineering, science, and emergency response fields, and provides advice to the CMG on directions, goals and services.

Figure 1 Front web page of the Center for Engineering Strong Motion Data

3. CESMD WEB SITE

The CESMD provides strong-motion data, metadata about stations and sites, and other services such as a search engine and interactive maps of events and stations through its web site. The web site is also the means of communicating between the Center and users in order to get feedback, answer questions regarding the data, and inform users about the updates at the Center. The web site, hosted by CGS and USGS at http://www.strongmotioncenter.org, consists of three major sections: Internet Quick Reports (IQR), Archive, and Search Engine. The front page of the Center's web site is shown in Figure 1. In addition to serving as a data source, the Center plans to notify users when important new data are available, and when important pages are updated.

The CESMD's web site is a dynamic web site in which all the web pages are generated on-the-fly upon a user's request. Data are retrieved from a database in real time when a user opens a web page. The dynamic nature of the database-driven system ensures that tables and maps will always contain the most updated information. Over the last 12 months, the number of users who access the CESMD web site to view and download data and metadata has increased significantly, by over a factor of 3, as shown in Figure 2.

3.1 The Internet Quick Reports

The CESMD provides the most current strong-motion data of engineering interest through the Internet Quick Reports (IQR) that are generated shortly after earthquakes. The first version of the IQR is often released within 30 minutes after the event. More complete IQR pages are posted as data are recovered and received by the Center. The Center plans to automate preliminary data processing and dissemination in the near future, which will make the information available more rapidly. An example of an IQR event summary page is shown in Figure 3. The user can access the Internet Quick Report for individual events by clicking on the event name on an event summary page. For example, Figure 3 shows the individual event page that is displayed by clicking on the table entry for the Loma Linda earthquake that occurred on June 23, 2008, in California.

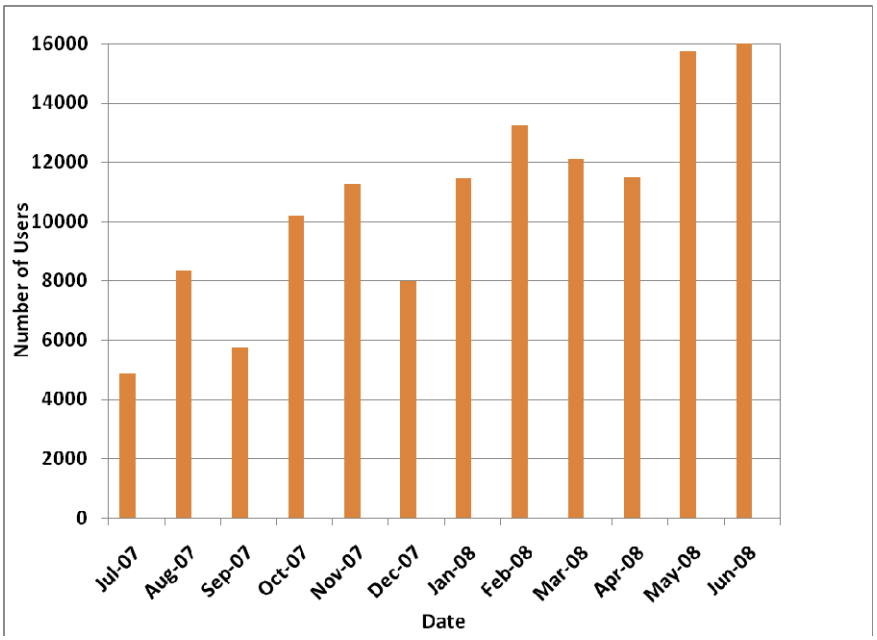


Figure 2 Number of users accessed the CESMD web site from July 2007 to June 2008

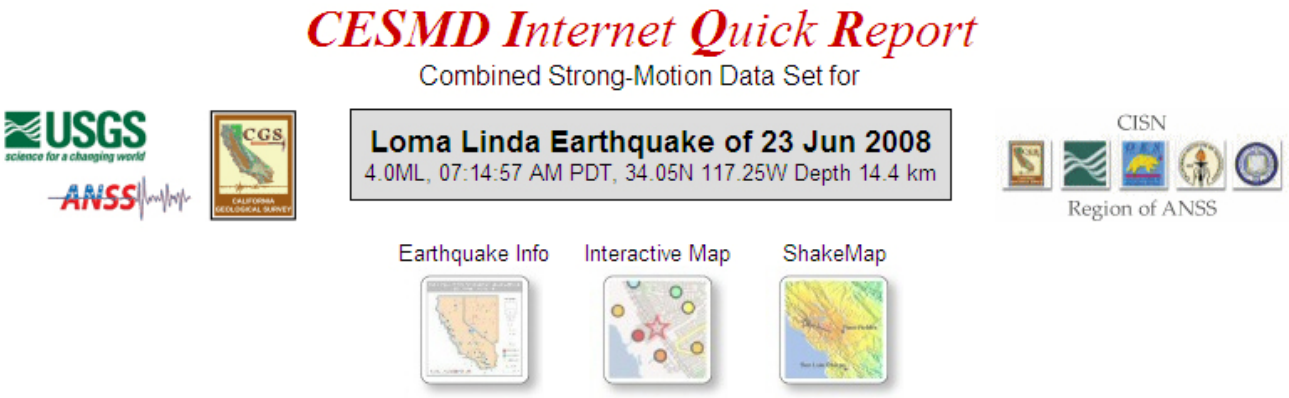
The main feature of the IQR page for each event is a sortable table summarizing key information about the record at each station, including station name, code, network, epicentral distance (plus distance to the causative fault, if available), and peak ground acceleration. Immediately above the table 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 in section 3.4.

Records from individual stations can be viewed and downloaded from the IQR page by clicking on the buttons in the appropriate columns on the right. Figure 4 shows an example of the acceleration time histories of the M4.7 Reno earthquake of April 25, 2008 recorded at the USGS station Martis Creek Dam.

Station information is accessible by clicking on the name in the Station column of the IQR table. 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 5 shows an example of the Station Information page for the 7-story University Hospital at the University of Southern California in Los Angeles, CA.

3.2 Archive

The Archive pages are sorted by event date (most recent on top). The layout of the Archive pages is the same as that of the IQR pages (e.g., Figure 3), so a user familiar with the IQR will find it easy to use the Archive pages. In the future, concurrent with the accumulation of data from new and recent events, the CESMD also will be adding more significant historic strong-motion records to the Archive.



Download Text Table

Last Update: 24 Jun 2008 5:08 PM PDT

Station	Code /ID	Network	Distance (km)		Horiz Apk (g)		View	Download
			Epic.	Fault	Ground	Struct.		
Moreno Valley - Sunnymead & Village	13080	CGS	9.0	--	**0.051**	--	○	○
Riverside - Airport	13123	CGS	21.2	--	**0.047**	--	○	○
Mills Filter Plant	5275	USGS	15.8	--	**0.034**	--	○	○
Rialto - I10 & Cedar	23899	CGS	13.8	--	**0.031**	--	○	○
Riverside - Hwy 91 & Central	13914	CGS	16.8	--	**0.026**	--	○	○
Riverside - Limonite & Downey	13921	CGS	23.3	--	**0.026**	--	○	○
Riverside, UCR campus	RSB	SCSN	11.1	--	**0.025**	--	○	○
San Bernardino - Mtn. View & Cluster	23780	CGS	6.2	--	**0.024**	--	○	○
San Bernardino - 6-story Hotel	23287	CGS	3.2	--	**0.021**	0.037	○	○
Colton, Grape St. and W. Mill St	CLT	SCSN	7.8	--	**0.020**	--	--	--
Redlands - Orange & Pennsylvania	23169	CGS	6.7	--	**0.019**	--	○	○
San Bernardino: FS No. 10	5339	USGS	5.8	--	**0.018**	--	○	○
Moreno Valley - Alessandro & Moreno Bch	13927	CGS	16.0	--	**0.017**	--	○	○
Moreno Valley - Indian & Kennedy	13925	CGS	16.5	--	**0.017**	--	○	○

Figure 3 An example of the tables in the IQR or Archive that summarize the records at stations for any event in CESMD

3.3 Searching for Data

Strong motion records of the Center are searchable using the “Search for Data” button on the Center’s front page.

Clicking on this button will display a search page that currently includes two search options, one for the CESMD and one for the COSMOS Virtual Data Center (VDC). Currently these two options are needed because the extent and scope of data holdings as well as the search options of these two data centers are incongruent (presently the VDC provides access to worldwide data). Future plans include incorporation of the Virtual Data Center (VDC) into the CESMD so that users will be able to access U.S. and significant international data through the CESMD web site.

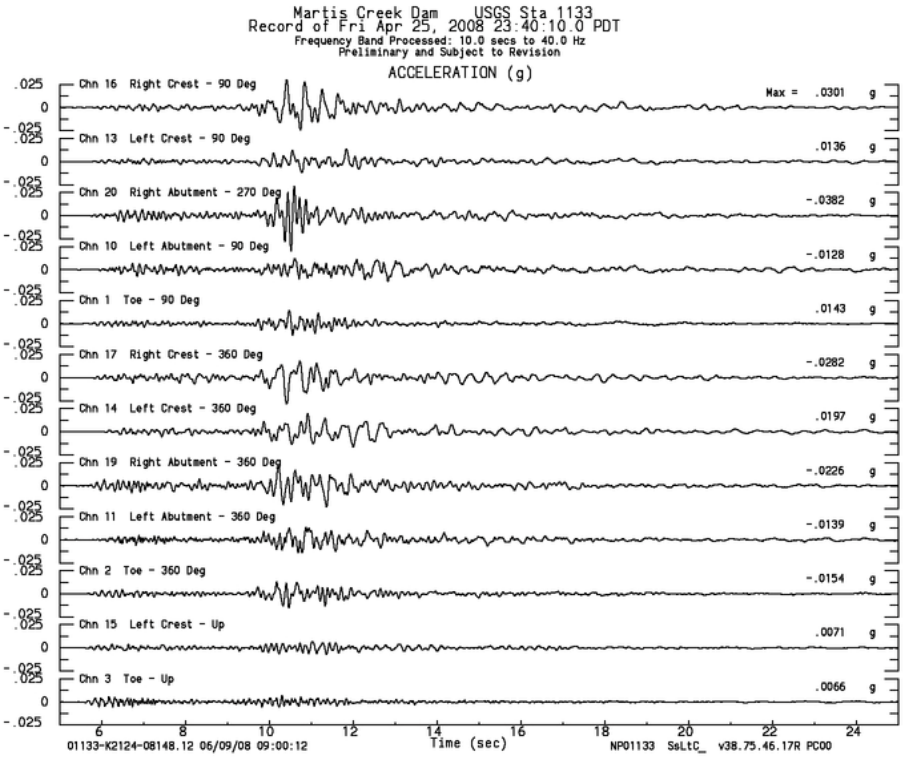


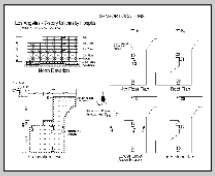
Figure 4 Acceleration time history of the M4.7 Reno earthquake of April 25, 2008 recorded at the USGS station Martis Creek Dam in Nevada

The current search page of the CESMD for U.S. structural and ground response data is shown in Figure 6. The records in the CESMD 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 currently earthquake name, magnitude and date. The station parameters are station city, station name, number, and type. The station types include ground stations, buildings, bridges, dams, geotechnical arrays, and others. For building stations, additional search parameters include material of construction (such as steel, concrete, masonry and wood), whether or not there is base-isolation, and the height (low, mid, and high rise). The search table can be sorted in the same way as an IQR or Archive table. The records found are directly viewable and downloadable from the search result table.

The Center provides ambient vibration data at some of the requested CGS stations through the search engine. The ambient data are loaded at the ftp site, linkable through a button at the bottom of the Search for Data page.

CESMD
Information for Strong-Motion Station
Los Angeles - 7-story Univ. Hospital
CGS - CSMIP Station No. 24605

(Station Photograph - click to enlarge)



(Sensor Layout - click to see PDF File)

Latitude	34.062 N
Longitude	118.198 W
Elevation (m)	115
Site Geology	Rock (sedimentary)
Vs30 (m/sec)	376
Site Class	--
Remarks	--

No. of Stories above/below ground	7/1
Plan Shape	S-shaped
Base Dimensions	303 x 253 ft (92.4 x 77.1 m)
Typical Floor Dimensions	303 x 253 ft (92.4 x 77.1 m)
Design Date	1988
Instrumentation	1991. 24 accelerometers, on 5 levels in the building. 3 accelerometers at a reference free-field site.

Figure 5 An example of the Station Information page for the University Hospital at USC, Los Angeles, CA

CESMD Combined Strong-Motion Data

Home | Archive | Search | Help and Comment

Search

Search for Data

Note: Leave fields blank that do not apply to your search.

Earthquake Name:
Magnitude: to Year (4-digit): to

Station (City, Name, or No.):
Station Type: Building
Material: Steel Height: High-rise
PGA (g): to Epicentral Dist. (km): to

Search Reset

OR

Ambient Data only

Figure 6 The CESMD Search for Data page facilitates searching for data via various search parameters

3.4. Interactive Map for Earthquake

The CESMD includes interactive Google Maps that allow users to view maps of strong motion stations and events. 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 coloring used on ShakeMap 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 distance scale 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, Terrain) 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 (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 at 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 view the time histories and download the strong-motion data. Clicking on the epicenter opens a pop-up window providing the basic information on the earthquake.
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. Figure 7 shows the interactive map for the M6.7 Hawaii earthquake of October 15, 2006.

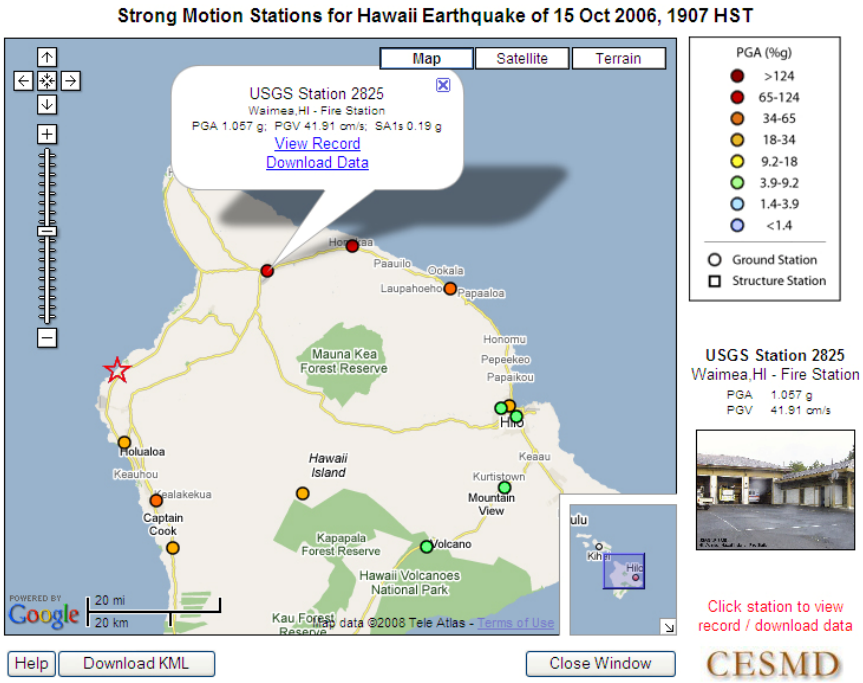


Figure 7 Google Map for the M6.7 Hawaii Earthquake of October 15, 2006

4. SUMMARY OF NEW DEVELOPMENTS

The CESMD is currently engaged in the process of transitioning the Virtual Data Center (VDC) to the CESMD for improved efficiency of operations and to provide all users with a more convenient one-stop portal to both US and significant international strong motion data.

Concurrently, the CESMD is working to implement modifications and enhancements to existing search options and display features in response to suggestions from the external Center 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 Center within a few minutes after a significant event and fully verified data soon afterwards. The records from all ANSS strong-motion networks will be uniformly processed and provided in the COSMOS format. The Center will notify registered users when important new pages are posted and/or when an existing page is significantly updated.

Another new development at the Center is the Interactive Station Maps tool which provides maps of all network stations in an area that are in the CESMD database. The maps also include stations that are planned or underway. Each station on the map is color coded to represent its seismic network. Also, users can access all data from different events recorded at any station by clicking on the station button on the map.

The Interactive Earthquake Event Map is another new tool using Google Map that shows all the earthquakes with strong-motion records available in the CESMD. The events are color coded to easily distinguish the significant events that have important strong-motion records from smaller events. By clicking on an event a pop-up window will provide a link to the list of all stations that have strong-motion records for that event. Thus all the data recorded and loaded in the CESMD for a station is easily downloadable and viewable through the Interactive Event Map.

ACKNOWLEDGMENTS

Jessica Zhang adopted a database for the Center and designed the new dynamic web pages. The Google Map feature of the Center was originally implemented by Peter Roffers and developments are continued by Jessica Zhang. We would like to acknowledge Jamie Steidl from UC Santa Barbara for his important role in the process of incorporating the Virtual Data Center in the CESMD. We would also like to acknowledge the CESMD Advisory Committee for their input and advice on improving the functionality and effectiveness of the Center.

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