

ShakeCast: A Tool for Post-Earthquake Decision-making and Response

Presentation for the Research Connection

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Caltrans

Division of Research & Innovation

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Kuo-Wan Lin

U.S. Geological Survey





Overview

- Project Background
- Development of ShakeCast
- Demonstration of Features

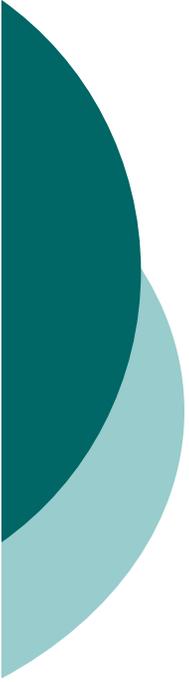
Motivation for the Project



- Timely response is critical to:
 - Ensure public safety
 - Aid routing of emergency vehicle traffic
 - Re-establish critical lifeline routes.

- Following a major earthquake, the Department must rapidly assess the condition of its bridges.

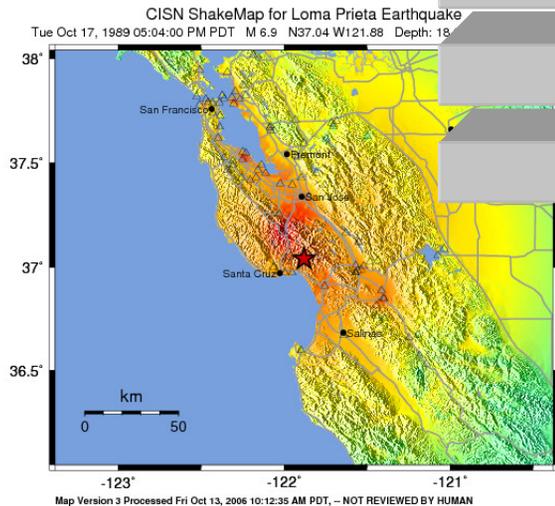
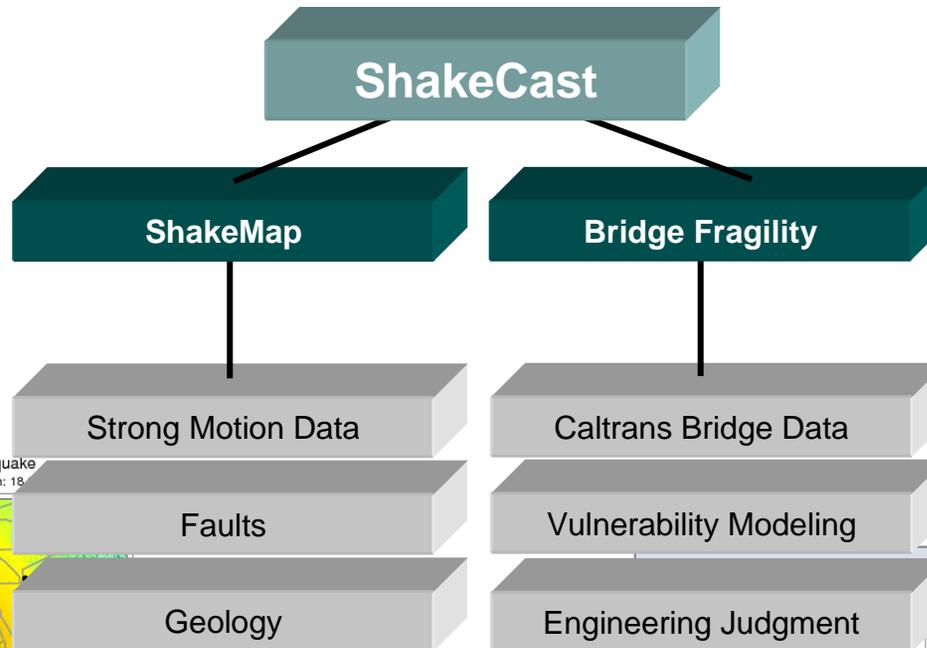




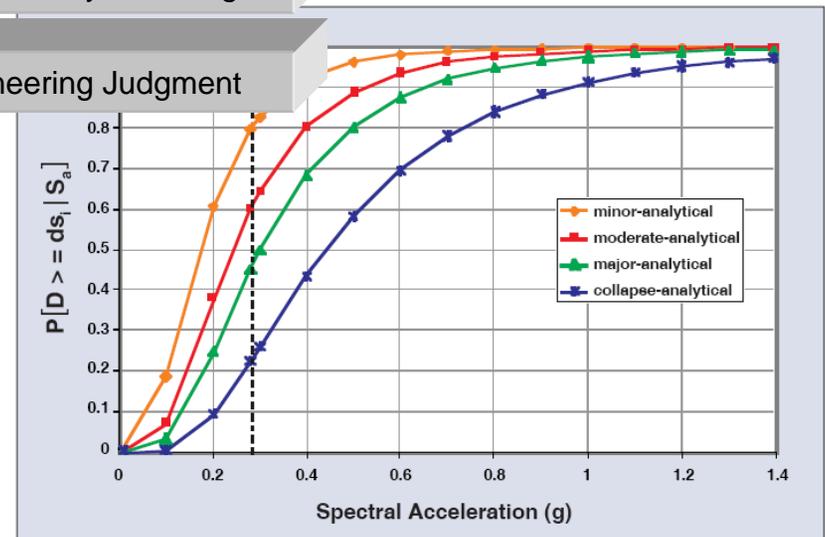
What is ShakeCast?

- ShakeCast
 - Software system that runs on a web server
 - Retrieves measured shaking data within minutes after an earthquake
 - Compares shaking distribution with unique bridge vulnerabilities
 - Provides hierarchical lists and maps of bridges most likely impacted
 - Emails info to responders
 - Provides suite of tools on website
- ShakeCast = *ShakeMap Broadcast*

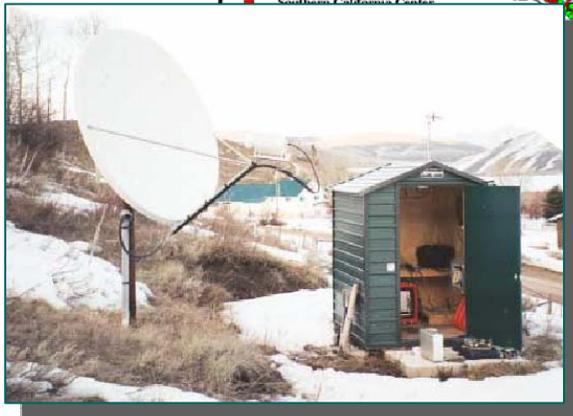
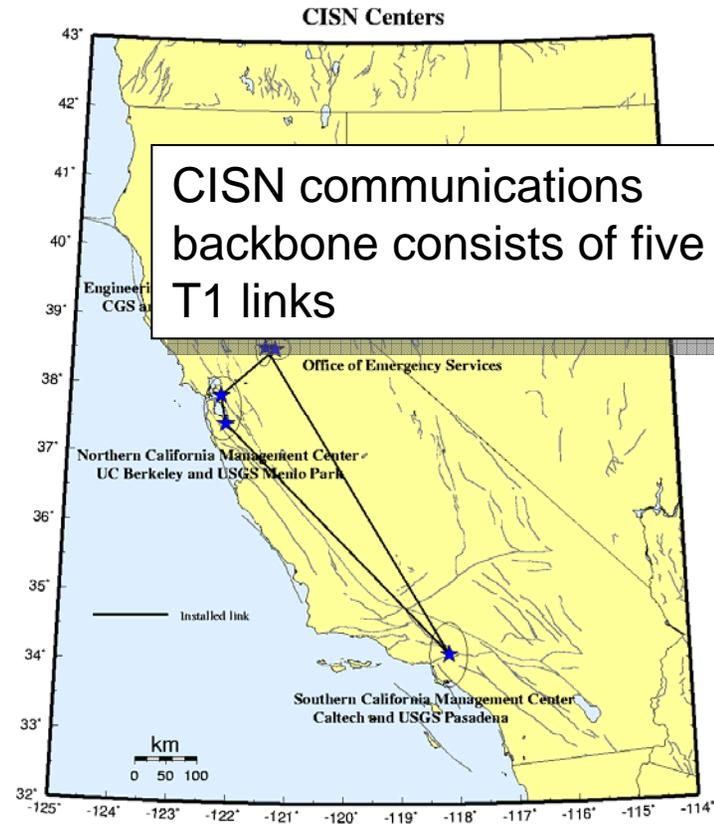
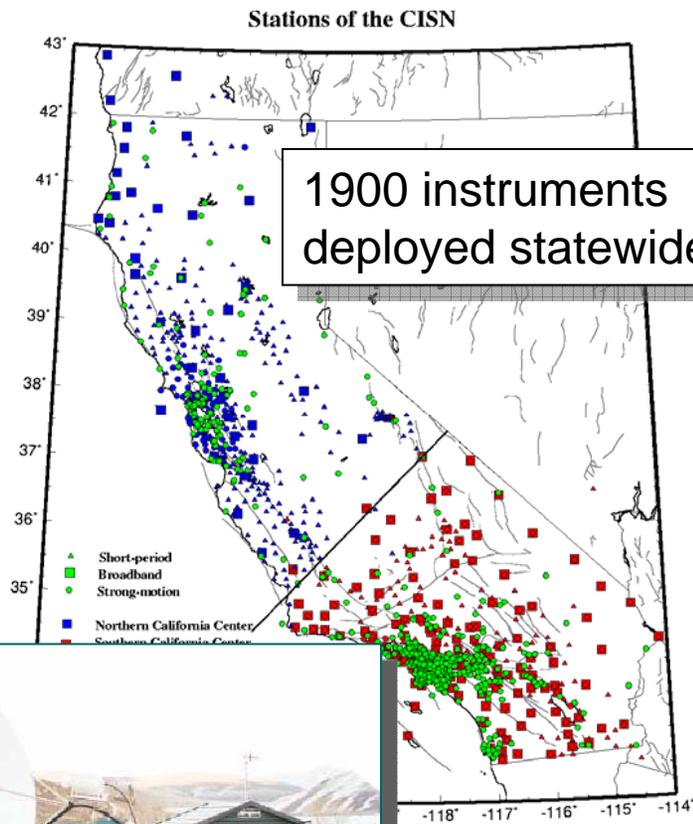
Foundation for ShakeCast



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.0	3.0-0.2	0.2-10	10-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-110	>110
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+



California Integrated Seismic Network (CISN)



CGS



USGS



Caltech



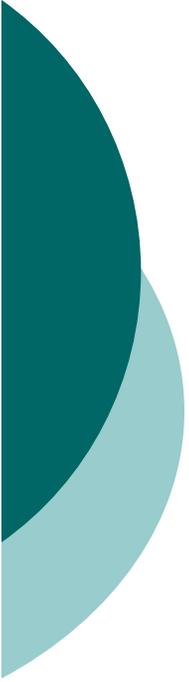
OES



UC
Berkeley

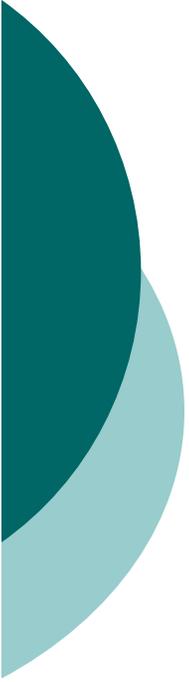
ShakeMap: Northridge (Mag. 6.7)





History

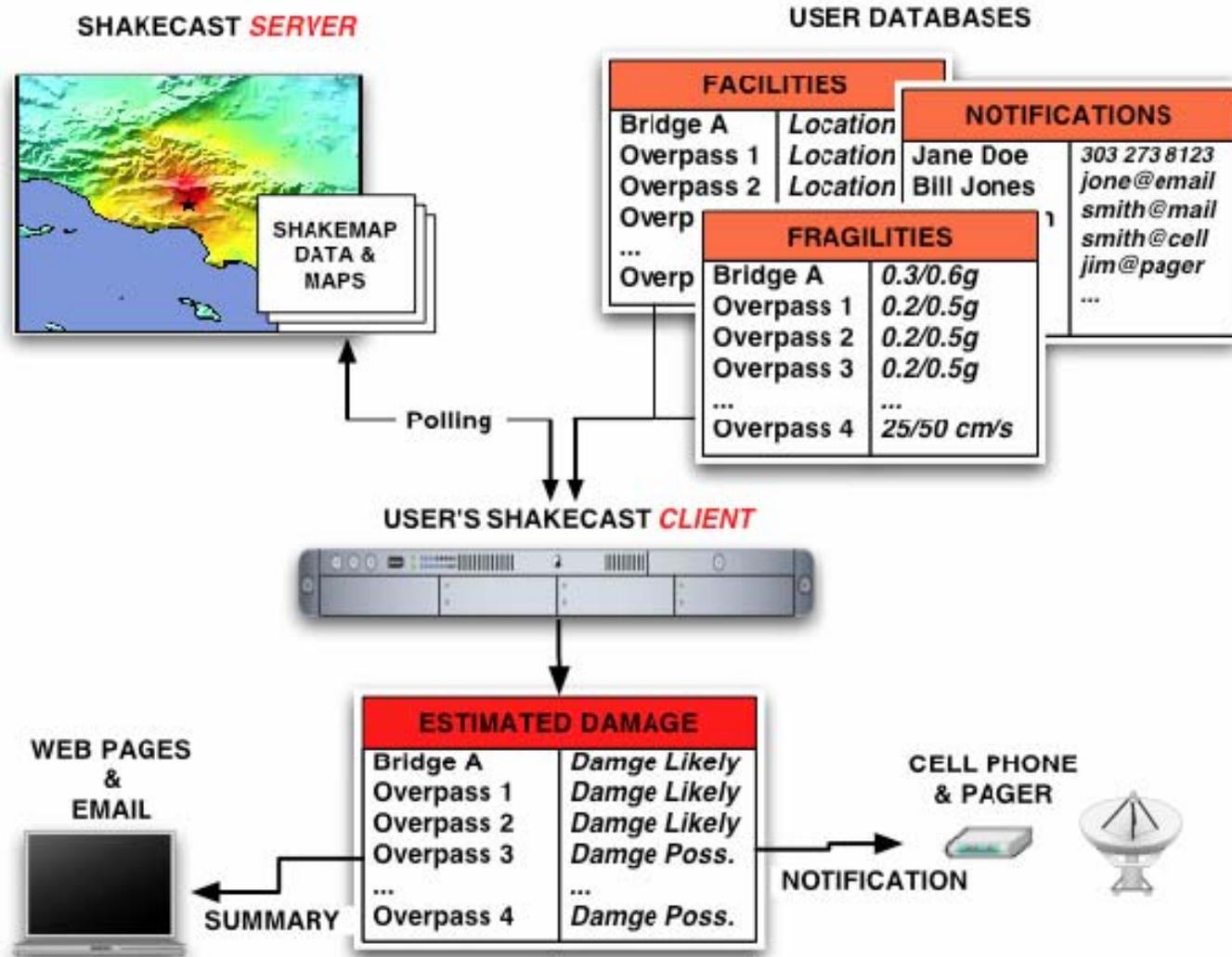
- 1996 – ShakeMap introduced
- 1999 – NT&R proposes “simple” method for assessing bridge impacts using ShakeMap and ArcView
- 2003 – ShakeCast Version 1 developed; Caltrans beta tester
- 2005 – Caltrans contracts with USGS
- 2008 – ShakeCast Version 2 released

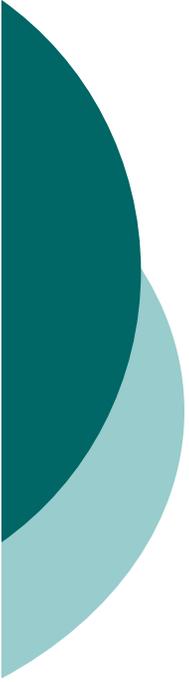


Project Details

- Contract with the United States Geological Survey (USGS) commenced in 2006.
- Scope of Work – develop ShakeCast system that provides:
 - Automated earthquake and bridge performance analysis
 - Produce maps and bridge inspection priority lists.
 - Web-based interface to administer system and provide suite of products to users.

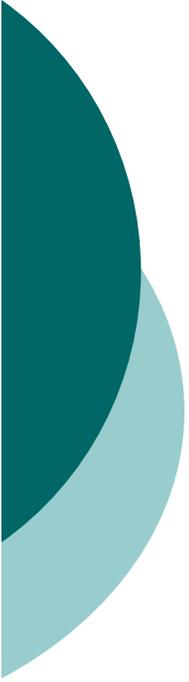
System Overview





ShakeCast Technologies

- WAMP
 - **W**indows (Server 2003)
 - **A**pache
 - **M**ySQL
 - **P**HP
- Perl
- Javascript
- RSS
- GoogleMaps
- GoogleEarth



ShakeCast Products

- Email notification
- GoogleEarth products
- ShakeCast Website

ShakeCast Email

- Automatic delivery of earthquake products to Caltrans.
- Automatic analysis of potential bridge damage state.
- Email bridge inspection prioritization lists.

Caltrans ShakeCast Server (C) To: Caltrans-ShakeCastAdmin@dot.ca.gov
 <Loren.Turner@dot.ca.gov> cc
 05/09/2008 11:18 AM bcc
 Subject: BRIDGE ASSESSMENT: 6.9, 7 km NNE of Aptos, CA (Loma_Prieta_ece Version 1)

Caltrans ShakeCast Preliminary Earthquake Bridge Impact Report

This report supersedes any earlier reports about this event. This is a computer-generated message and has not yet been reviewed by an Engineer or Seismologist. Information about the epicenter, magnitude, location, date, and time are provided by the California Integrated Seismic Network (CISN). The analysis of potential bridge damage in this report is based upon an initial [ShakeMap](#) (unverified) and estimated fragilities for Caltrans bridges. Bridge fragility models were adopted from HAZUS and Basoz & Mander (1999). This report is intended to be used as a first response tool to assist in identifying Caltrans bridges most likely impacted by the event.

CISN ShakeMap for Loma Prieta Earthquake
 Tue Oct 17, 1989 05:04:00 PM PDT M 6.9 N37.64 W121.88 Depth: 18.0km ID: Loma_Prieta

Map Version: 3 Processed Fri Oct 13, 2006 10:32:35 AM PDT. - NOT REVERSED BY HUMAN

Intensity	Very light	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
Scale	1-2	3	4	5	6	7	8	9
Peak Acc. (g)	< 0.1	0.1-0.2	0.2-0.5	0.5-1.0	1.0-2.0	2.0-5.0	5.0-10.0	> 10.0
Peak Vel. (cm/s)	< 0.1	0.1-0.3	0.3-0.8	0.8-1.8	1.8-3.8	3.8-8.0	8.0-15.0	> 15.0
Intensity	I	II	III	IV	V	VI	VII	VIII

Event Summary
 Name: (Unnamed Event) - Version 1
 Magnitude: 6.9
 ID: Loma_Prieta_sca-1
 Location: 7 km NNE of Aptos, CA
 Latitude: 37.04
 Longitude: -121.88
 Time: 1989-10-18 00:04:00 GMT

Downloads & Resources
 Caltrans Intranet Links: [Caltrans ShakeCast Intranet](#), [Caltrans ShakeMap Products](#)
 GoogleEarth KML files: [ShakeCast Bridge Assessment](#), [Statewide Bridge Inventory](#), [Caltrans Real-Time Traffic](#), [USGS Real-Time Earthquakes](#)

Bridge Assessment Summary
 Maximum Peak 1.0 sec Spectral Acceleration: 105.3903g
 Maximum Acceleration: (not measured)
 Total number of bridges assessed: 2030
 Summary by inspection priority:

Priority	Count	Description
High	22	High Priority for full engineering assessment
Medium-High	107	Medium-High Priority for full engineering assessment
Medium	106	Medium Priority for full engineering assessment
Low	1795	Low Priority for full engineering assessment; quick visual inspection likely sufficient.

Bridge Assessment Details
 Bridges presented in the table below are sorted in order of severity of impact to bridges.

Bridge Name	Bridge Number	Dist-Cty-Rte-PM	Inspection Priority	1sec Peak Spectral Acceleration (%)	Exceedance Ratio
Ralston Avenue OC	35 0114	04-SM-101-0-55-BMT	High	105.3903	2.934
Via Del Oro OH	37 0477L	04-SCL-085-1-22-SJS	High	49.2711	2.472
San Mateo-Hayward Bridge	35 0054	04-SM-092-R14.44-FSTC	High	49.6514	2.167
Constitution Way OC	33 0513K	04-ALA-260-R-86-ALA	High	68.2755	1.415
Meridian Road Underpass	37 0258	04-SCL-280-R3-80-SJS	High	59.9229	1.122
Campbell Underpass	37 0136	04-SCL-017-1-22-CMB	High	70.2112	1.087
East Hillsdale Blvd OC	35 0138	04-SM-101-11-15-SM	High	68.3762	1.071
Redwood Creek	35 0145	04-SM-101-6-2-RDWC	High	61.0924	1.064
Stobb-Approach Lower Deck	34 0118R	04-SF-080-4-95-SF	High	33.2578	1.057
Holly Street OC	35 0037	04-SM-101-8-4	High	65.904	1.048
Route 1380 Separation (North)	33 0191G	04-ALA-013-13-92-BER	High	66.6766	1.046
Race Street Overcrossing	37 0280	04-SCL-280-R3-76-SJS	High	59.9229	1.045
Presidio Viaduct	34 0019	04-SF-101-0-14-SF	High	68.3123	1.035
South Delaware Street UC	35 0158L	04-SM-092-R11.61-SM	High	35.1822	1.030
South Delaware Street UC	35 0158R	04-SM-092-R11.61-SM	High	35.1822	1.030
Powell Street UC	33 0020	04-ALA-080-3-79-EMV	High	66.6766	1.020
Redwood Harbor Overhead	35 0065	04-SM-101-5-RDWC	High	56.8606	1.018
Macarthur Avenue OC	37 0100	04-SCL-280-L5-18-SJS	High	54.4613	1.012
N101-S84 Connector OC	35 0081G	04-SM-101-5-39-RDWC	High	56.8606	1.009
N171-H85 Connector Separation	37 0515G	04-SCL-017-0-24-LGST	High	68.2137	1.008
San Francisco Creek	35 0013	04-SM-101-0-1	High	55.3678	1.007
N887-S280 Connector Separation	37 0366H	04-SCL-087-5-1-SJS	High	50.5564	1.001
Blossom Hill Road OC	37 0345	04-SCL-062-R-35-SJS	Medium-High	49.4998	0.951
Hankins Slough Road OC	35 0099	05-SCR-001-R22-27-MAAT	Medium-High	56.0768	0.938
Sand Street Br UC	37 0263L	04-SCL-280-R3-41-SJS	Medium-High	62.8878	0.909
Sand Street Br UC	37 0263R	04-SCL-280-R3-41-SJS	Medium-High	62.8878	0.909

Caltrans ShakeCast Server (C) To: Caltrans-ShakeCastAdmin@dot.ca.gov
 <Loren.Turner@dot.ca.gov> cc
 05/09/2008 11:18 AM bcc
 Subject: BRIDGE ASSESSMENT: 6.9, 7 km NNE of Aptos, CA (Loma_Prieta_scte Version 1)

Caltrans ShakeCast Preliminary Earthquake Bridge Impact Report

This report supersedes any earlier reports about this event. This is a computer-generated message and has not yet been reviewed by an Engineer or Seismologist. Information about the epicenter, magnitude, location, date, and time are provided by the California Integrated Seismic Network (CISN). The analysis of potential bridge damage in this report is based upon an initial [ShakeMap](#) (unverified) and estimated fragilities for Caltrans bridges. Bridge fragility models were adopted from HAZUS and Basoz & Mander (1999). This report is intended to be used as a first response tool to assist in identifying Caltrans bridges most likely impacted by the event.



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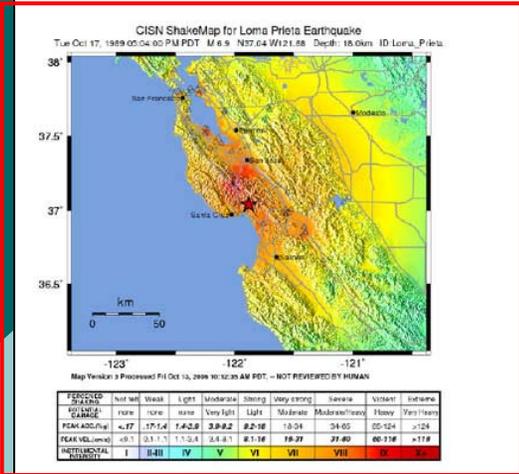
Event Name:
 Magnitude:
 Location:
 Latitude:
 Longitude:
 Time:
 Bridge:
 Maximum:
 Total:
 Summary:
 High:
 Medium:
 Low:
 Bridge:
 Bridge:

Religion Avenue OC	35 0114	04-SM-101-9-35-BM1	High	105.3693	2.364
Via Del Oro OH	37 0477L	04-SCL-085-1-22-SJS	High	49.2711	2.472
San Mateo-Hayward Bridge	35 0054	04-SM-092-R14.44-FSTC	High	49.6514	2.167
Constitution Way OC	33 0513K	04-ALA-260-R.86-ALA	High	68.2755	1.415
Meridian Road Underpass	37 0258	04-SCL-280-R3.89-SJS	High	59.9229	1.122
Campbell Underpass	37 0135	04-SCL-017-12.22-CMB	High	70.2112	1.087
East Hillside Blvd OC	35 0138	04-SM-101-11-15-SM	High	68.3762	1.071
Redwood Creek	35 0145	04-SM-101-4-2-RDWC	High	61.9924	1.064
Stobb-Approach Lower Deck	34 0118R	04-SF-080-4-95-SF	High	33.2578	1.057
Holly Street OC	35 0037	04-SM-101-8.4	High	65.904	1.048
Route 13/80 Separation (North)	33 0191G	04-ALA-013-13.92-BER	High	66.6766	1.046
Race Street Overcrossing	37 0260	04-SCL-280-R3.76-SJS	High	59.9229	1.045
Presidio Viaduct	34 0019	04-SF-101-9-14-SF	High	68.3123	1.035
South Delaware Street UC	35 0158L	04-SM-092-R11.61-SM	High	35.1822	1.030
South Delaware Street UC	35 0158R	04-SM-092-R11.61-SM	High	35.1822	1.030
Powell Street UC	33 0020	04-ALA-080-3.79-EMV	High	66.6766	1.020
Redwood Harbor Overhead	35 0065	04-SM-101-5.5-RDWC	High	56.8606	1.018
Macarthur Avenue OC	37 0100	04-SCL-280-L5.18-SJS	High	54.4613	1.012
N101-S84 Connector OC	35 0081G	04-SM-101-5.39-RDWC	High	56.8606	1.009
N17-N85 Connector Separation	37 0515G	04-SCL-017-9.24-LGTS	High	86.2137	1.008
San Francisco Creek	35 0013	04-SM-101-01	High	55.3678	1.007
N85-S280 Connector Separation	37 0366H	04-SCL-087-5.1-SJS	High	50.5564	1.001
Blossom Hill Road OC	37 0345	04-SCL-082-R.35-SJS	Medium-High	49.4998	0.951
Harkins Slough Road OC	36 0080	05-SCR-001-R2.27-WAT	Medium-High	56.0768	0.938
Sund Street Rr UC	37 0263L	04-SCL-280-R3.41-SJS	Medium-High	52.8878	0.909
Sund Street Rr UC	37 0263R	04-SCL-280-R3.41-SJS	Medium-High	52.8878	0.909

Caltrans ShakeCast Server (C) To: Caltrans-ShakeCastAdmin@dot.ca.gov
 <Loren.Turner@dot.ca.gov> cc
 05/09/2008 11:18 AM bcc
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Event Summary
 Name: (Unnamed Event), Version 1
 Magnitude: 6.9
 ID: Loma_Prieta_scte-1
 Location: 7 km NNE of Aptos, CA
 Latitude: 37.04
 Longitude: -121.68
 Time: 1989-10-18 00:04:00 GMT

Downloads & Resources
 Caltrans Intranet Links:
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[Caltrans ShakeMap Products](#)
 GoogleEarth KML files:
[ShakeCast Bridge Assessment](#)
[Statewide Bridge Inventory](#)
[Caltrans Real-time Traffic](#)
[USGS Real-time Earthquakes](#)

Bridge Assessment Summary
 Maximum Peak 1.0 sec Spectral Acceleration: 105.3903%g
 Maximum Acceleration: (not measured)
 Total number of bridges assessed: 2039
 Summary by inspection priority:
High 22 High Priority for full engineering assessment
Medium-High 107 Medium-High Priority for full engineering assessment
Medium 108 Medium Priority for full engineering assessment
Low 1795 Low Priority for full engineering assessment; quick visual inspection likely sufficient.

Bridge Assessment Details
 Bridges presented in the table below are sorted in order of severity of impact to bridges.

Bridge Name	Bridge Number	Dist-City-Rte-PM	Inspection Priority	1sec Peak Spectral Acceleration (%g)	Exceedance Ratio
Ralston Avenue OC	35 0114	04-SM-101-9.55-BMT	High	105.3903	2.934
Via Del Oro OH	37 0477L	04-SCL-085-1.22-SJS	High	49.2711	2.472
San Mateo-Hayward Bridge	35 0054	04-SM-092-R14.44-FSTC	High	49.6514	2.167
Constitution Way OC	33 0513K	04-ALA-260-R.86-ALA	High	68.2755	1.415
Meridian Road Underpass	37 0258	04-SCL-280-R3.89-SJS	High	59.9229	1.122
Campbell Underpass	37 0135	04-SCL-017-12.22-CMB	High	70.2112	1.087
East Hillside Blvd OC	35 0138	04-SM-101-11.15-SM	High	68.3762	1.071
Ridwood Creek	35 0145	04-SM-101-6.2-RDWC	High	61.9924	1.064
Stobb-Approach Lower Deck	34 0118R	04-SF-090-4.95-SF	High	33.2578	1.057
Holly Street OC	35 0037	04-SM-101-8.4	High	65.904	1.048
Route 13/80 Separation (North)	33 0191G	04-ALA-013-13.92-BER	High	66.6766	1.046
Race Street Overcrossing	37 0260	04-SCL-280-R3.76-SJS	High	59.9229	1.045
Presidio Viaduct	34 0019	04-SF-101-9.14-SF	High	68.3123	1.035
South Delaware Street UC	35 0158L	04-SM-092-R11.61-SM	High	35.1822	1.030
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Powell Street UC	33 0020	04-ALA-090-3.79-EMV	High	66.6766	1.020
Redwood Harbor Overhead	35 0065	04-SM-101-5.5-RDWC	High	56.8606	1.018
Macarthur Avenue OC	37 0100	04-SCL-280-L5.18-SJS	High	54.4613	1.012
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CISN Rapid Instrumental Intensity Map for Loma Prieta Earthquake
 Tue Oct 17, 1989 05:04:00 PM PDT M 6.9 N37.04 W121.68 Depth: 18.0km ID:Loma_Prieta



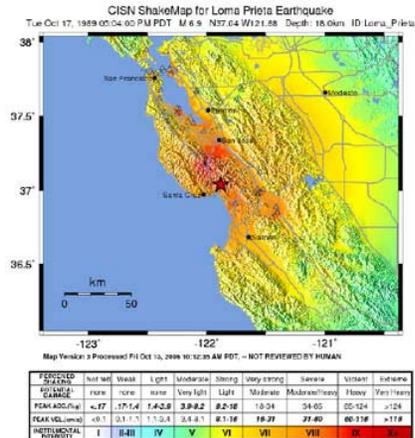
PROCESSED: Thu Nov 6, 2003 06:53:05 AM PST,

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC (%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL (cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

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 Version 1)

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Race Street Overcrossing	37 0260	04-SCL-280-R3.76-SJS	High	59.9229	1.045
Presidio Viaduct	34 0019	04-SF-101-9.14-SF	High	68.3123	1.035
South Delaware Street UC	35 0158L	04-SM-092-R11.61-SM	High	35.1822	1.030
South Delaware Street UC	35 0158R	04-SM-092-R11.61-SM	High	35.1822	1.030
Powell Street UC	33 0020	04-ALA-090-3.79-EMV	High	66.6766	1.020
Redwood Harbor Overhead	35 0065	04-SM-101-5.5-RDWC	High	56.8606	1.018
Macarthur Avenue OC	37 0100	04-SCL-280-L5.18-SJS	High	54.4613	1.012
N101-S84 Connector OC	35 0081G	04-SM-101-5.39-RDWC	High	56.8606	1.009
N17-N85 Connector Separation	37 0515G	04-SCL-017-9.24-LGTS	High	86.2137	1.008
San Francisco Creek	35 0013	04-SM-101-01	High	55.3678	1.007
N85-S280 Connector Separation	37 036H	04-SCL-087-5.1-SJS	High	50.5564	1.001
Blossom Hill Road OC	37 0345	04-SCL-082-R.35-SJS	Medium-High	49.4998	0.951
Harkins Slough Road OC	36 0080	05-SCR-001-R2.27-WAT	Medium-High	56.0768	0.938
Sund Street Rr UC	37 0263L	04-SCL-280-R3.41-SJS	Medium-High	52.8878	0.909
Sund Street Rr UC	37 0263R	04-SCL-280-R3.41-SJS	Medium-High	52.8878	0.909

Event Summary

Name: (Unnamed Event) , Version 1
 Magnitude: 6.9
 ID: Loma_Prieta_scte-1
 Location: 7 km NNE of Aptos, CA
 Latitude: 37.04
 Longitude: -121.88
 Time: 1989-10-18 00:04:00 GMT

Downloads & Resources

Caltrans Intranet Links:

[Caltrans ShakeCast Intranet](#)
[Caltrans ShakeMap Products](#)

GoogleEarth KML files:

(save to your computer as a KML file and open with GoogleEarth)

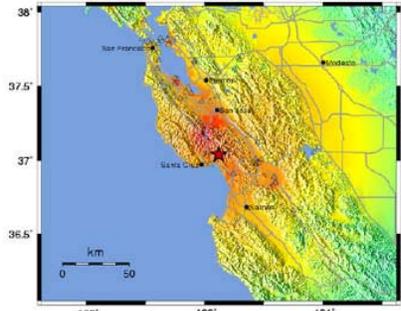
[ShakeCast Bridge Assessment](#)
[Statewide Bridge Inventory](#)
[Caltrans Real-time Traffic](#)
[USGS Real-time Earthquakes](#)

Caltrans ShakeCast Server (C) To: Caltrans-ShakeCastAdmin@dot.ca.gov
 <Loren.Turner@dot.ca.gov> cc
 bcc
 05/09/2008 11:18 AM Subject: BRIDGE ASSESSMENT: 6.9, 7 km NNE of Aptos, CA (Loma_Prieta_scte Version 1)

Caltrans ShakeCast Preliminary Earthquake Bridge Impact Report

This report supersedes any earlier reports about this event. This is a computer-generated message and has not yet been reviewed by an Engineer or Seismologist. Information about the epicenter, magnitude, location, date, and time are provided by the California Integrated Seismic Network (CISN). The analysis of potential bridge damage in this report is based upon an initial ShakeMap (unverified) and estimated fragilities for Caltrans bridges. Bridge fragility models were adopted from HAZUS and Basoz & Mander (1999). This report is intended to be used as a first response tool to assist in identifying California bridges most likely impacted by the event.

CISN ShakeMap for Loma Prieta Earthquake
 Tue Oct 17, 1989 00:04:00 P.U.P.D.T. M 6.9 N37.64 W121.68 Depth: 18.0km ID: Loma_Prieta



Map Version: 3 Processed Fri Oct 10, 2008 10:52:30 AM PDT - NOT REVIEWED BY HUMAN

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	0.17-1.4	1.4-2.8	2.8-5.8	5.8-10.4	10.4-34.05	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-2.4	2.4-4.1	4.1-10	10-37	37-80	80-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Event Summary
 Name: (Unnamed Event), Version 1
 Magnitude: 6.9
 ID: Loma_Prieta_scte-1
 Location: 7 km NNE of Aptos, CA
 Latitude: 37.04
 Longitude: -121.68
 Time: 1989-10-18 00:04:00 GMT

Downloads & Resources

- Caltrans Intranet Links:
 - Caltrans ShakeCast Intranet
 - Caltrans ShakeMap Products
- GoogleEarth KML files:
 - ShakeCast Bridge Assessment
 - Statewide Bridge Inventory
 - Caltrans Real-time Traffic
 - USGS Real-time Earthquakes

Bridge Assessment Summary

Maximum Peak 1.0 sec Spectral Acceleration: 105.3903%g
 Maximum Acceleration: (not measured)
 Total number of bridges assessed: 2030
 Summary by inspection priority:

High	22	High Priority for full engineering assessment
Medium-High	107	Medium-High Priority for full engineering assessment
Medium	108	Medium Priority for full engineering assessment
Low	1795	Low Priority for full engineering assessment; quick visual inspection likely sufficient.

Bridge Assessment Details

Bridges presented in the table below are sorted in order of severity of impact to bridges.

Bridge Name	Bridge Number	Dist-City-Rte-PM	Inspection Priority	1sec Peak Spectral Acceleration (%g)	Exceedance Ratio
Ralston Avenue OC	35 0114	04-SM-101-0-55-BMT	High	105.3903	2.934
Via Del Oro OH	37 0477L	04-SCL-085-1-22-SJS	High	49.2711	2.472
San Mateo-Hayward Bridge	35 0054	04-SM-092-R14.44-FSTC	High	49.6514	2.167
Constitution Way OC	33 0513K	04-ALA-280-R.86-ALA	High	68.2755	1.415
Meridian Road Underpass	37 0258	04-SCL-280-R3.89-SJS	High	59.9229	1.122
Campbell Underpass	37 0135	04-SCL-017-12-22-CMB	High	70.2112	1.087
East Hillsdale Blvd OC	35 0138	04-SM-101-11-15-SM	High	68.3762	1.071
Redwood Creek	35 0145	04-SM-101-4-2-RDWC	High	61.9924	1.064
Stebb-Approach Lower Deck	34 0118R	04-SF-090-4-95-SF	High	33.2578	1.057
Holly Street OC	35 0037	04-SM-101-8.4	High	65.904	1.048
Route 13/80 Separation (North)	33 0191G	04-ALA-013-13.92-BER	High	66.6766	1.046
Race Street Overcrossing	37 0260	04-SCL-280-R3.76-SJS	High	59.9229	1.045
Presidio Viaduct	34 0019	04-SF-101-9-14-SF	High	68.3123	1.035
South Delaware Street UC	35 0158L	04-SM-092-R11.61-SM	High	35.1822	1.030
South Delaware Street UC	35 0158R	04-SM-092-R11.61-SM	High	35.1822	1.030
Power Street UC	33 0020	04-ALA-090-3.79-EMV	High	66.6766	1.020
Redwood Harbor Overhead	35 0065	04-SM-101-5.5-RDWC	High	56.8606	1.018
Macarthur Avenue OC	37 0100	04-SCL-280-15.18-SJS	High	54.4613	1.012
N101-S84 Connector OC	35 0081G	04-SM-101-5.39-RDWC	High	56.8606	1.009
N17-N85 Connector Separation	37 0515G	04-SCL-017-9.24-LGTS	High	86.2137	1.008
San Francisco Creek	35 0013	04-SM-101-01	High	55.3678	1.007
N85-S7-S280 Connector Separation	37 0396H	04-SCL-087-5.1-SJS	High	50.5564	1.001
Blossom Hill Road OC	37 0345	04-SCL-082-R.35-SJS	Medium-High	49.4998	0.951
Harkins Slough Road OC	36 0080	05-SCR-001-R2.27-WAT	Medium-High	56.0768	0.938
Sund Street Rr UC	37 0263L	04-SCL-280-R3.41-SJS	Medium-High	52.8878	0.909
Sund Street Rr UC	37 0263R	04-SCL-280-R3.41-SJS	Medium-High	52.8878	0.909

Google Earth Pro interface showing a ShakeMap overlay on a map of the San Francisco Bay Area. A pop-up window for '23Rd Street Oc' provides detailed information:

USGS ShakeMap: Maps of recorded and estimated seismic ground shaking intensity

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	0.17-1.4	1.4-2.8	2.8-5.8	5.8-10.4	10.4-34.05	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-2.4	2.4-4.1	4.1-10	10-37	37-80	80-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

23Rd Street Oc
 Bridge Name: 23Rd Street Oc
 Bridge Number: 34 0035
 Dist-City-Rte-PM: 04-SF-101-3.37-SF
 Latitude: 37.755
 Longitude: -122.4036
 Year Built: 1953
 Post 1975 Retrofit: Y
 Structure Type: Steel
 Stringer/Multi-Beam Or Girder
 NEHRP Soil Type: D
 Closest Fault: Midway-San Joaquin/N*
 Max Credible EQ: 6.75
 Distance to Fault (m): 25939.6
 Directions: [To here](#) - [From here](#)

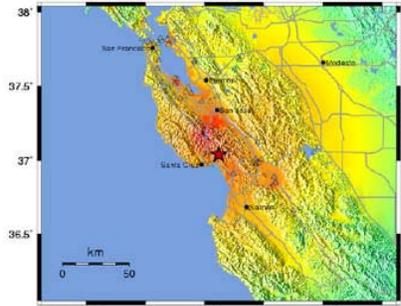
Map labels include: Berkeley, Treasure Island, Yerba Buena Crossing, 17th Street Ramp Separation, N880-E980 Connector Oc, Rte 980, Madison Street Uc, Webster Street Tube, Constil, 18Th Street Poc, 23Rd Street Oc, 22Nd Street Poc, Bayshore Blvd Uc, Southern Freeway Viaduct, Cortland Ave Uc, Faith Street Poc, Alemany Circle Uc, Alemany Circle Uc, Silver Avenue, Bacon Street Uc, 18Th Street Oc, China Basin Viaduct, Central Viaduct, 18Th Street Poc, 23Rd Street Oc, 22Nd Street Poc, Bayshore Blvd Uc, Southern Freeway Viaduct, Cortland Ave Uc, Faith Street Poc, Alemany Circle Uc, Alemany Circle Uc, Silver Avenue, Bacon Street Uc.

Caltrans ShakeCast Server (C) To: Caltrans-ShakeCastAdmin@dot.ca.gov
 <Loren.Turner@dot.ca.gov> cc
 05/09/2008 11:18 AM bcc
 Subject: BRIDGE ASSESSMENT: 6.9, 7 km NNE of Aptos, CA (Loma_Prieta_scte_Ver
 1)

Caltrans ShakeCast Preliminary Earthquake Bridge Impact Report

This report supersedes any earlier reports about this event. This is a computer-generated message and has not yet been reviewed by an Engineer or Seismologist. Information about the epicenter, magnitude, location, date, and time are provided by California Integrated Seismic Network (CISN). The analysis of potential bridge damage in this report is based upon an initial ShakeMap (unverified) and estimated fragilities for Caltrans bridges. Bridge fragility models were adopted from HAZUS and B & Mander (1999). This report is intended to be used as a first response tool to assist in identifying Caltrans bridges most likely impacted by the event.

CISN ShakeMap for Loma Prieta Earthquake
 Tue Oct 17, 1989 05:04:00 PM PDT M 6.9 N37.64 W121.68 Depth: 18.0km ID:Loma_Prieta



Map Version: 3 Processed Fri Oct 10, 2008 10:52:35 AM PDT - NOT REVIEWED BY HUMAN

SECTORED SHAKES	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
PEAK ACCEL.	<.17	.17-1.4	1.4-2.8	2.8-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VCL VELOCITY	<0.1	0.1-1.1	1.1-2.4	2.4-8.1	8.1-18	18-37	37-80	80-138	>138
INSTRUMENTAL RADIATION	I	II-III	IV	V	VI	VII	VIII	IX	X

Event Summary

Name: (Unnamed Event), Version 1
 Magnitude: 6.9
 ID: Loma_Prieta_scte-1
 Location: 7 km NNE of Aptos, CA
 Latitude: 37.04
 Longitude: -121.68
 Time: 1989-10-18 00:04:00 GMT

Downloads & Resources

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[Caltrans ShakeMap Products](#)
 GoogleEarth KML files:
[ShakeCast Bridge Assessment](#)
[Statewide Bridge Inventory](#)
[Caltrans Real-time Traffic](#)
[USGS Real-time Earthquakes](#)

Bridge Assessment Summary

Maximum Peak 1.0 sec Spectral Acceleration: 105.3903g
 Maximum Acceleration: (not measured)
 Total number of bridges assessed: 2030
 Summary by inspection priority:
High 22 High Priority for full engineering assessment
Medium-High 107 Medium-High Priority for full engineering assessment
Medium 108 Medium Priority for full engineering assessment
Low 1795 Low Priority for full engineering assessment; quick visual inspection likely sufficient

Bridge Assessment Details

Bridges presented in the table below are sorted in order of severity of impact to bridges.

Bridge Name	Bridge Number	Dist-Cty-Rte-PM	Inspection Priority	1sec Peak Spectral Acceleration (%)	Exceedance Ratio
Ralston Avenue OC	35 0114	04-SM-101-9.55-BMT	High	105.3903	2.934
Via Del Oro OH	37 0477L	04-SCL-085-1.22-SJS	High	49.2711	2.472
San Mateo-Hayward Bridge	35 0054	04-SM-092-R14.44-FSTC	High	49.6514	2.167
Constitution Way OC	33 0513K	04-ALA-260-R.86-ALA	High	68.2755	1.415
Meridian Road Underpass	37 0258	04-SCL-280-R3.89-SJS	High	59.9229	1.122
Campbell Underpass	37 0135	04-SCL-017-12.22-CMB	High	70.2112	1.087
East Hillsdale Blvd OC	35 0138	04-SM-101-11.15-SM	High	68.3762	1.071
Redwood Creek	35 0145	04-SM-101-6.2-RDWC	High	61.0924	1.064
Sfobb-Approach Lower Deck	34 0118R	04-SF-080-4.95-SF	High	33.2578	1.057
Holly Street OC	35 0037	04-SM-101-8.4	High	65.904	1.048
Route 13/80 Separation (North)	33 0191G	04-ALA-013-13.92-BER	High	66.6766	1.046
Race Street Overcrossing	37 0260	04-SCL-280-R3.76-SJS	High	59.9229	1.045
Presidio Viaduct	34 0019	04-SF-101-9.14-SF	High	68.3123	1.035
South Delaware Street UC	35 0158L	04-SM-092-R11.61-SM	High	35.1822	1.030
South Delaware Street UC	35 0158R	04-SM-092-R11.61-SM	High	35.1822	1.030
Powell Street UC	33 0020	04-ALA-080-3.79-EMV	High	66.6766	1.020
Redwood Harbor Overhead	35 0065	04-SM-101-5.5-RDWC	High	56.8606	1.018
Macarthur Avenue OC	37 0100	04-SCL-280-L5.18-SJS	High	54.4613	1.012
N101-S84 Connector OC	35 0081G	04-SM-101-5.39-RDWC	High	56.8606	1.009
N17-N85 Connector Separation	37 0515G	04-SCL-017-9.24-LGTS	High	86.2137	1.008
San Francisquito Creek	35 0013	04-SM-101-01	High	55.3678	1.007
N&S87-S280 Connector Separation	37 0396H	04-SCL-087-5.1-SJS	High	50.5564	1.001
Blossom Hill Road OC	37 0345	04-SCL-082-R.35-SJS	Medium-High	49.4998	0.951
Harkins Slough Road OC	36 0089	05-SCR-001-R2.27-WAT	Medium-High	56.0768	0.938
Sunol Street Rr UC	37 0263L	04-SCL-280-R3.41-SJS	Medium-High	52.8878	0.909
Sunol Street Rr UC	37 0263R	04-SCL-280-R3.41-SJS	Medium-High	52.8878	0.909
Winchester Boulevard OC	37 0195	04-SCL-280-4.57-SJS	Medium-High	55.327	0.898
Lincoln Avenue UC	37 0262L	04-SCL-280-R3.51-SJS	Medium-High	52.8878	0.896
South Gilroy OH	37 0305L	04-SCL-101-R5.1	Medium-High	43.2728	0.896

Bridge Assessment Summary

Maximum Peak 1.0 sec Spectral Acceleration: 188.76%g
 Maximum Acceleration: (not measured)
 Total number of bridges assessed: 3133
 Summary by inspection priority:

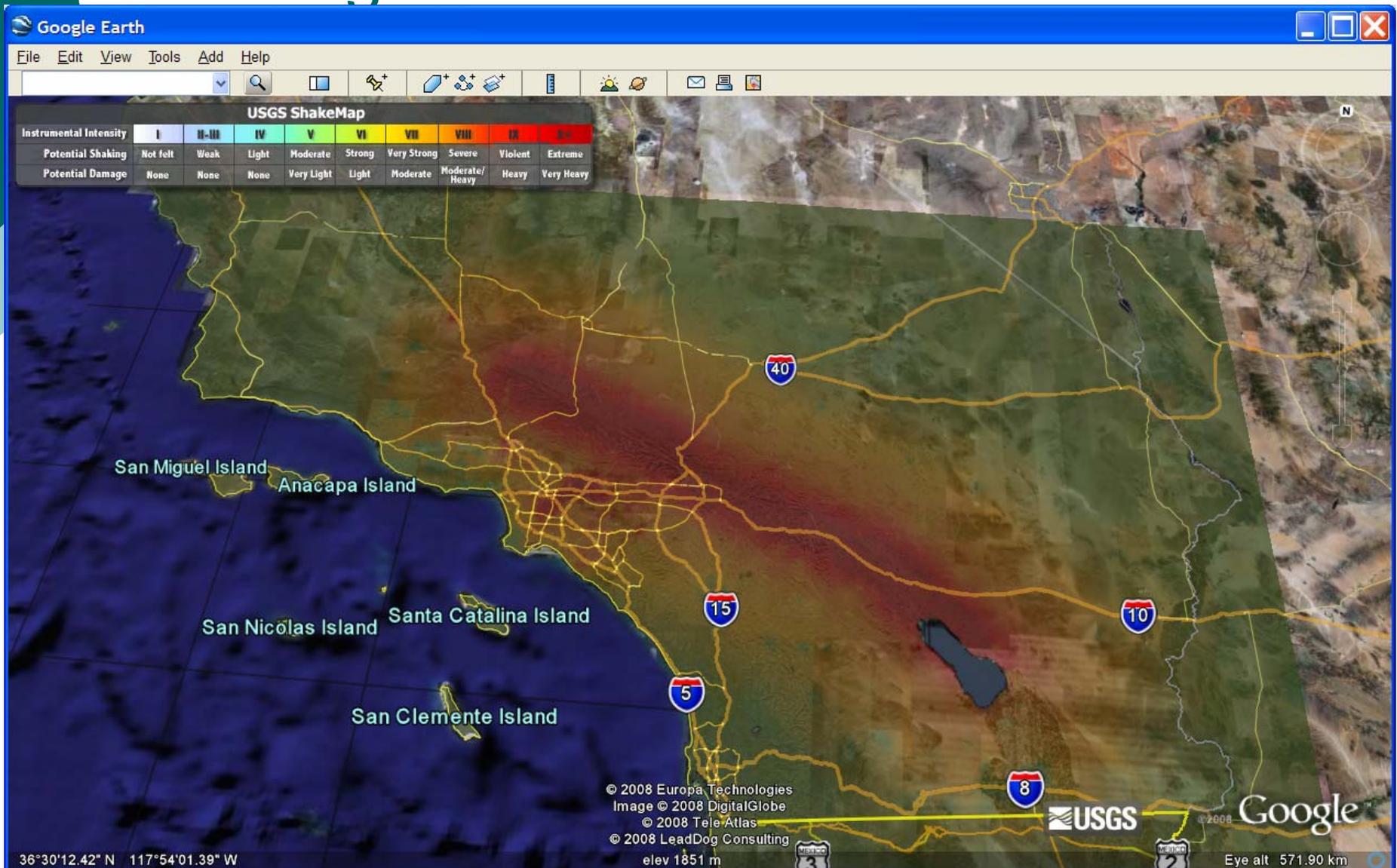
High	119	High Priority for full engineering assessment
Medium-High	156	Medium-High Priority for full engineering assessment
Medium	152	Medium Priority for full engineering assessment
Low	2706	Low Priority for full engineering assessment; quick visual inspection likely sufficient.

Bridge Assessment Details

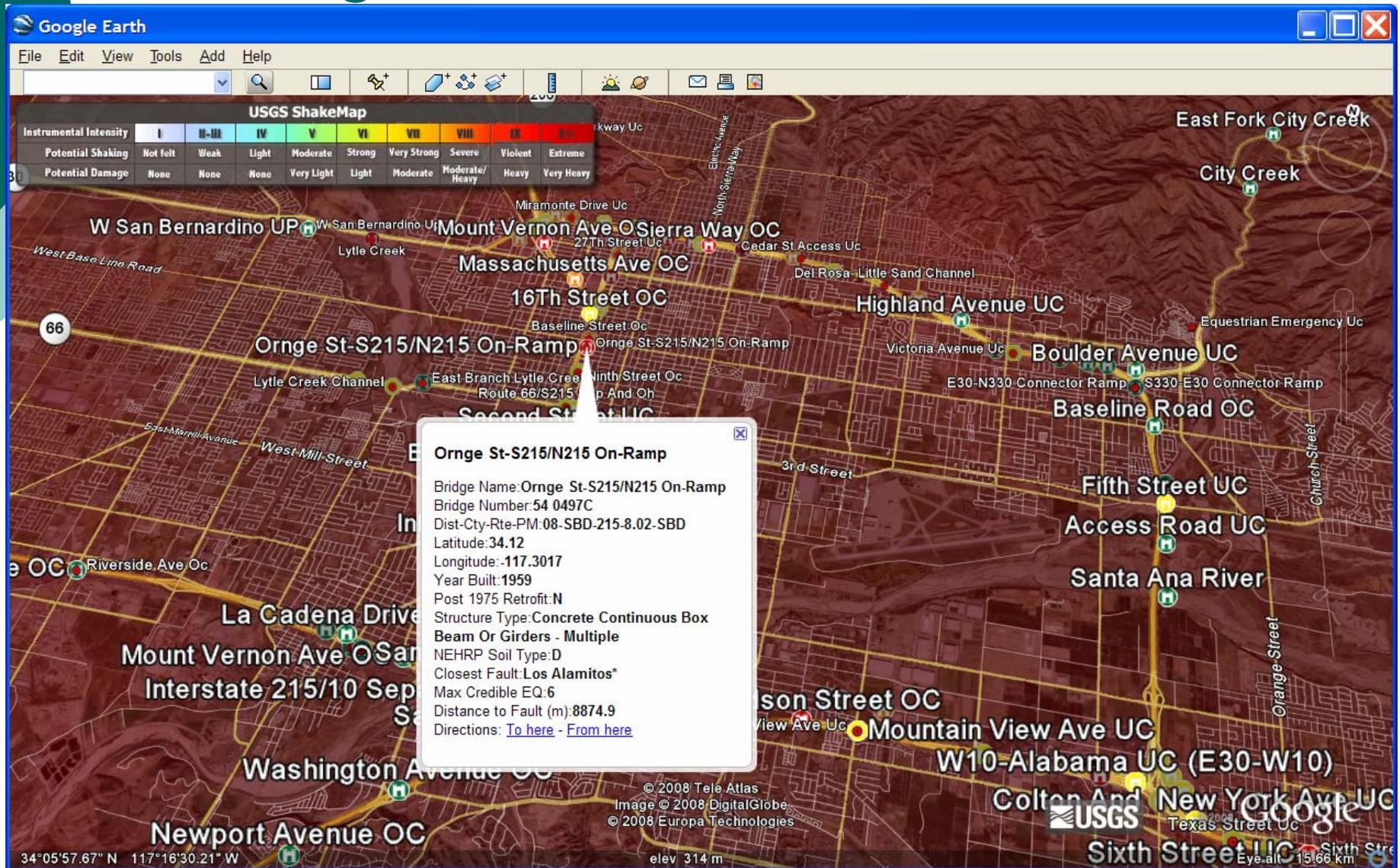
Bridges presented in the table below are sorted in order of severity of impact to bridges.

Bridge Name	Bridge Number	Dist-Cty-Rte-PM	Inspection Priority	1sec Peak Spectral Acceleration (%)	Exceedance Ratio
Ralston Avenue OC	35 0114	04-SM-101-9.55-BMT	High	105.3903	2.934
Via Del Oro OH	37 0477L	04-SCL-085-1.22-SJS	High	49.2711	2.472
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Route 13/80 Separation (North)	33 0191G	04-ALA-013-13.92-BER	High	66.6766	1.046
Race Street Overcrossing	37 0260	04-SCL-280-R3.76-SJS	High	59.9229	1.045
Presidio Viaduct	34 0019	04-SF-101-9.14-SF	High	68.3123	1.035
South Delaware Street UC	35 0158L	04-SM-092-R11.61-SM	High	35.1822	1.030
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N101-S84 Connector OC	35 0081G	04-SM-101-5.39-RDWC	High	56.8606	1.009
N17-N85 Connector Separation	37 0515G	04-SCL-017-9.24-LGTS	High	86.2137	1.008
San Francisquito Creek	35 0013	04-SM-101-01	High	55.3678	1.007
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Sunol Street Rr UC	37 0263R	04-SCL-280-R3.41-SJS	Medium-High	52.8878	0.909
Winchester Boulevard OC	37 0195	04-SCL-280-4.57-SJS	Medium-High	55.327	0.898
Lincoln Avenue UC	37 0262L	04-SCL-280-R3.51-SJS	Medium-High	52.8878	0.896
South Gilroy OH	37 0305L	04-SCL-101-R5.1	Medium-High	43.2728	0.896

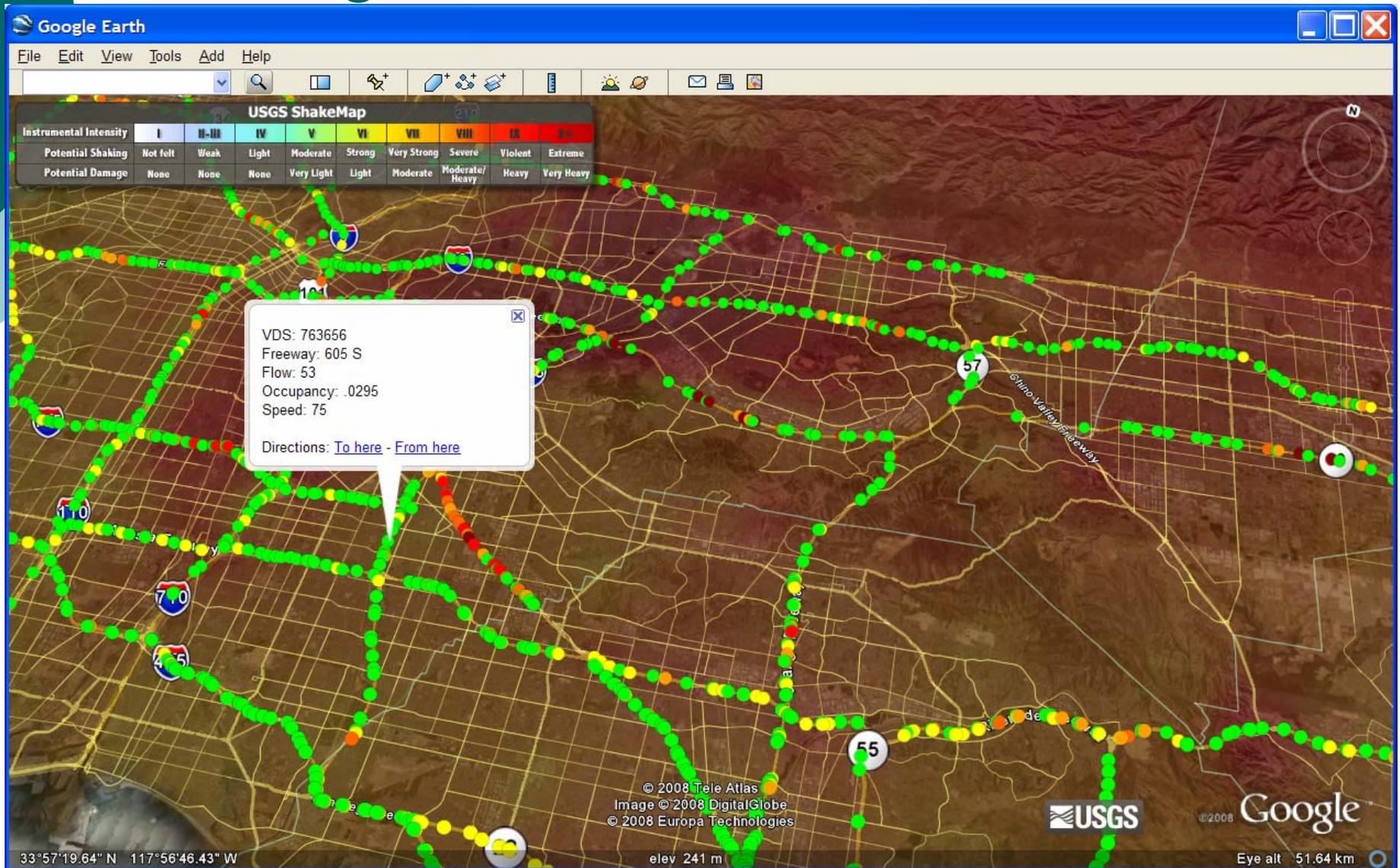
GoogleEarth and ShakeCast



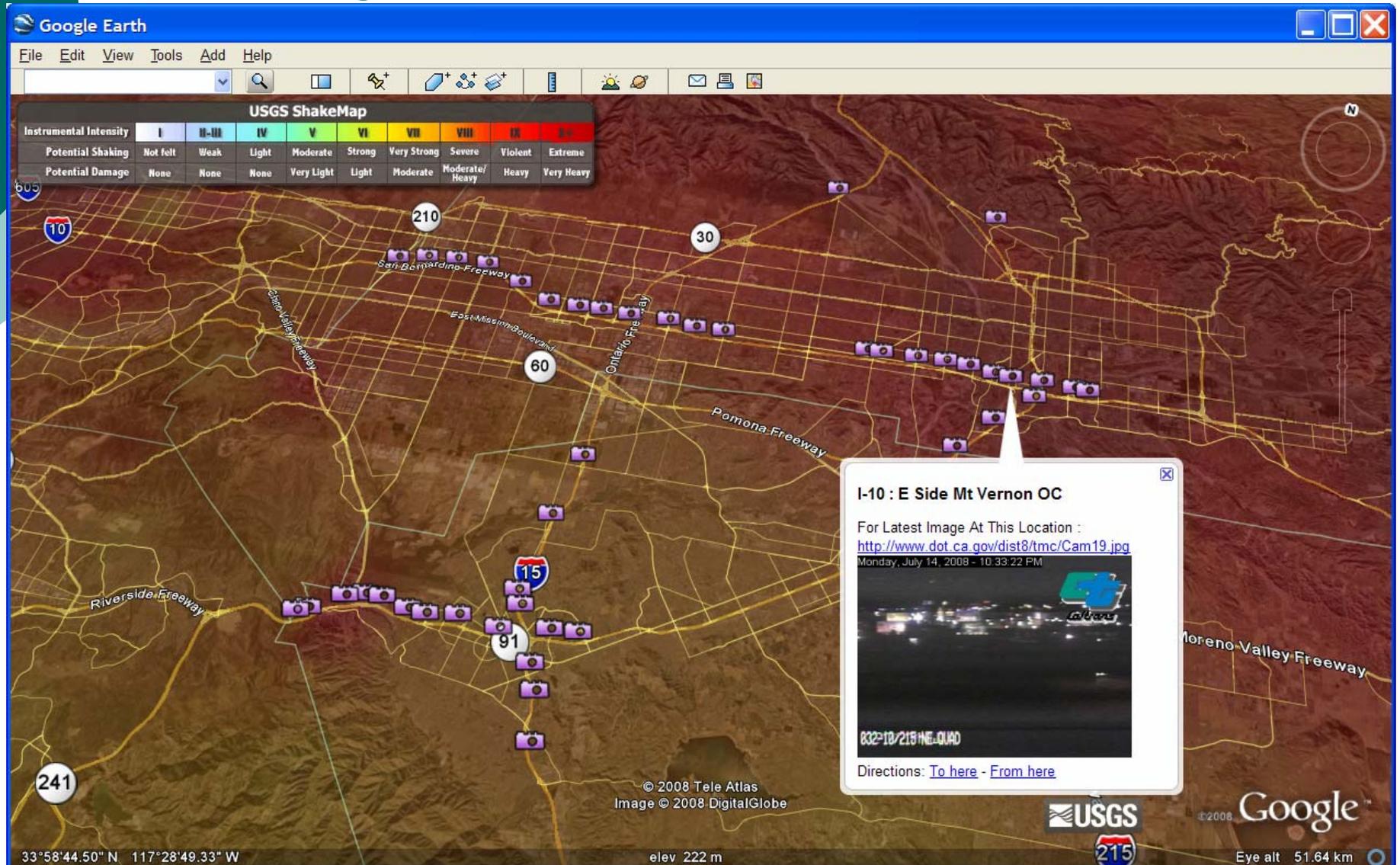
GoogleEarth and ShakeCast



GoogleEarth and ShakeCast



GoogleEarth and ShakeCast

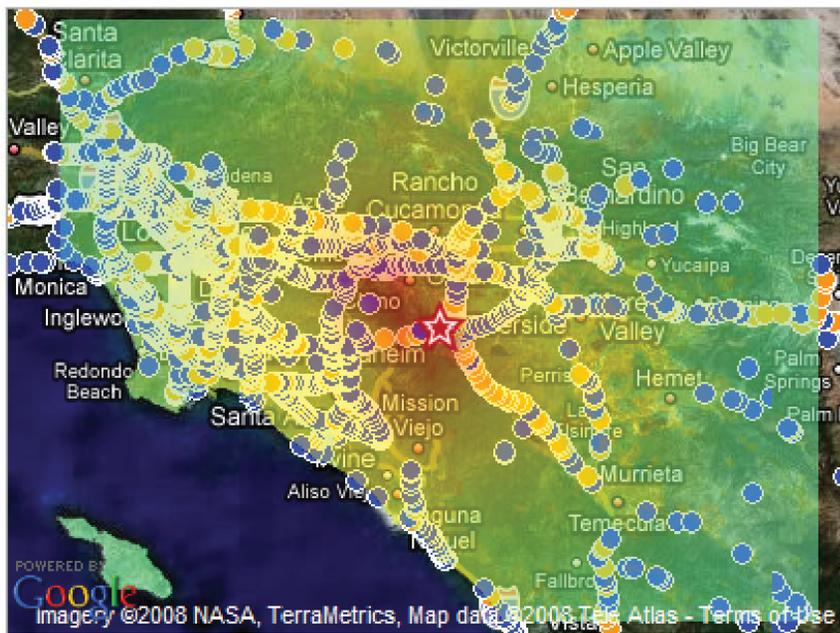


ShakeCast Website

CALTRANS SHAKE CAST 2

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Jump to:



ShakeCast Summary

892

10
14
1

Number of facilities evaluated: **917**
Instrumental Intensity : **IV - VIII**
Peak Ground Acceleration (%g): **4.4817 - 48.7128**
Peak Ground Velocity (cm/sec): **2.3475 - 74.1758**
Peak Spectral Acc. at 0.3 sec (%g): **8.5875 - 124.5867**
Peak Spectral Acc. at 1.0 sec (%g): **2.4797 - 78.3554**
Peak Spectral Acc. at 3.0 sec (%g): **1.2125 - 23.9314**

M 6.7 - Chino Hills Fault Scenario

ID: Chino_Hills6.7_se_scte Version: 5
Origin Time: 2005-05-30 12:00:00
Location: -117.6, 33.9

Map View

M 6.7 - Chino Hills Fault Scenario (ID: Chino_Hills6.7_se_scte - 5)

Facility ID	Type	Description	Inspection Priority ▼	Latitude	Longitude	MMI	PGA (%g)	PGV (cm/sec)	PSA03 (%g)	PSA10 (%g)	PSA30 (%g)
56 0633	BRIDGE	Green River Drive OC	High	33.87848421	-117.6578573	VIII	46.6934	61.9509	119.4515	64.2799	19.6343
54 0748	BRIDGE	Benson Avenue OC	Medium-High	34.03032662	-117.6804218	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
54 0747	BRIDGE	Central Avenue OC	Medium-High	34.03026777	-117.6891927	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 1873G	BRIDGE	E60-N57 Connector OC	Medium-High	34.02202039	-117.8133506	VIII	39.693	47.723	101.3087	50.4097	17.9044
53 1788	BRIDGE	Fairway Drive UC	Medium-High	33.99852901	-117.8703981	VIII	35.7487	38.3302	90.7622	40.4898	16.1639
56 0497	BRIDGE	Magnolia Avenue OC	Medium-High	33.87848421	-117.6578573	VIII	46.6934	61.9509	119.4515	64.2799	19.6343
54 0746	BRIDGE	Monte Vista Avenue OC	Medium-High	34.03032662	-117.6804218	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
54 0744	BRIDGE	Pipeline Avenue OC	Medium-High	34.03032662	-117.6804218	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 1873	BRIDGE	Prospectors UC	Medium-High	34.03032662	-117.6804218	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
54 0745	BRIDGE	Ramona Avenue OC	Medium-High	34.03032662	-117.6804218	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 1933	BRIDGE	Spadra OH	Medium-High	34.03032662	-117.6804218	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 2106	BRIDGE	State Street OC	Medium-High	34.03032662	-117.6804218	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 2078K	BRIDGE	Valley Blvd UC	Medium-High	34.03032662	-117.6804218	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 2078	BRIDGE	Valley Blvd UC	Medium-High	34.03032662	-117.6804218	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
56 0445	BRIDGE	West Grand Blvd UC	Medium-High	33.87848421	-117.6578573	VIII	46.6934	61.9509	119.4515	64.2799	19.6343
53 2081R	BRIDGE	Garey Ave UC	Medium	34.03032662	-117.6804218	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 2081L	BRIDGE	Garey Ave UC	Medium	34.03032662	-117.6804218	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 1022L	BRIDGE	Gibson OH (Eb&Wb Buswy)	Medium	34.03032662	-117.6804218	VIII	37.8311	42.8441	96.2983	45.2159	16.1476

Map View Close

Map Satellite Hybrid

Green River Drive OC

Lat: 33.87848421 Lon: -117.6578573

MMI:	8.56
PGA:	46.6934
PGV:	61.9509
PSA03:	119.4515
PSA10:	64.2799
PSA30:	19.6343

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Table View

Google Maps for ShakeMap Chino_Hills6.7_se_scte

Facility Type: All BRIDGE

The map interface displays a satellite view of the Corona, California area. Numerous bridge locations are marked with icons: green house-like icons for 'UC BRIDGE', red house-like icons for 'OC BRIDGE', and yellow house-like icons for 'BRIDGE'. A red star icon is located in the center of the map. The right-hand side of the interface features a vertical list of bridge names and their types, each in a colored box corresponding to its icon on the map. The list includes: West Prado OH BRIDGE (green), Green River Drive OC BRIDGE (red), Santa Ana River BRIDGE (yellow), Serfas Drive UC BRIDGE (green), Smith Avenue OC BRIDGE (green), Maple Street OC BRIDGE (green), Buena Vista Avenue UC BRIDGE (green), Lincoln Avenue OC BRIDGE (green), Main Street UC BRIDGE (green), West Grand Blvd UC BRIDGE (orange), Magnolia Avenue OC BRIDGE (orange), Sixth Street UC BRIDGE (green), Sixth Street UC BRIDGE (green), Temescal Wash BRIDGE (green), and Temescal Wash (green). The map includes navigation controls on the left and top, and a Google logo at the bottom left. Imagery is attributed to TerraMetrics and map data to Tele Atlas.

West Prado OH BRIDGE
Green River Drive OC BRIDGE
Santa Ana River BRIDGE
Serfas Drive UC BRIDGE
Smith Avenue OC BRIDGE
Maple Street OC BRIDGE
Buena Vista Avenue UC BRIDGE
Lincoln Avenue OC BRIDGE
Main Street UC BRIDGE
West Grand Blvd UC BRIDGE
Magnolia Avenue OC BRIDGE
Sixth Street UC BRIDGE
Sixth Street UC BRIDGE
Temescal Wash BRIDGE
Temescal Wash

Upcoming Features for Website

Shake - Mozilla Firefox

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- Research & Innovation
- Earthquake Engineering
- Geotechnical Services

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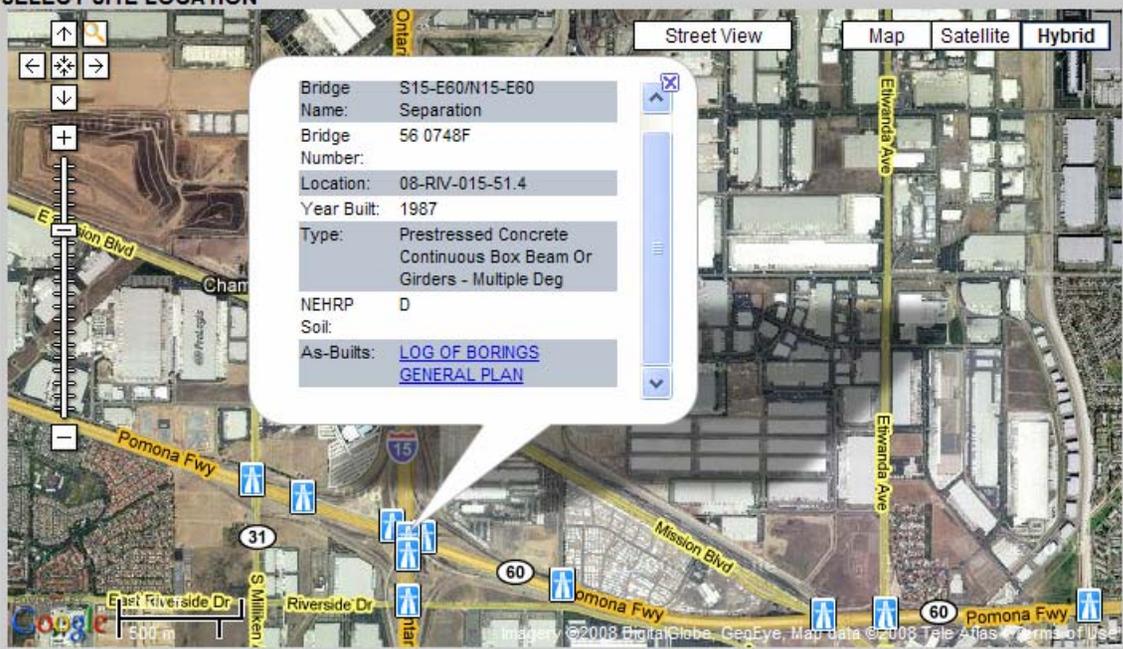


Caltrans ARS Online

This web-based tool calculates both deterministic and probabilistic acceleration response spectra for any location in California based on criteria provided in *Appendix B of Caltrans Seismic Design Criteria*. More...

SELECT SITE LOCATION

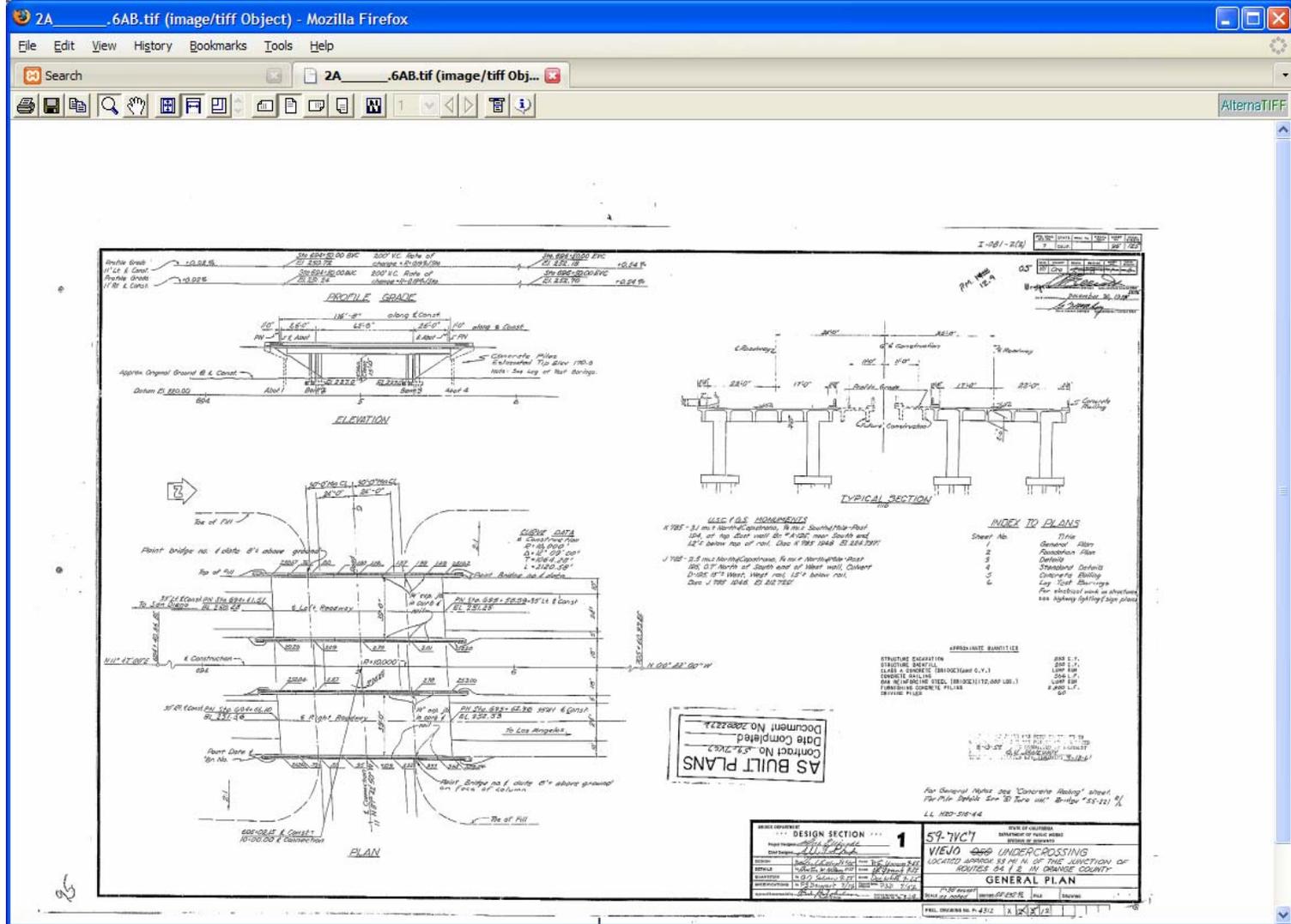
Street View Map Satellite Hybrid



Bridge: S15-E60/N15-E60
Name: Separation
Bridge Number: 56 0748F
Location: 08-RIV-015-S1.4
Year Built: 1987
Type: Prestressed Concrete Continuous Box Beam Or Girders - Multiple Deg
NEHRP: D
Soil:
As-Built: [LOG OF BORINGS](#)
[GENERAL PLAN](#)

Latitude: 34.02055835 Longitude: -117.5502807 V₃₀: m/s **Calculate**

Upcoming Features for Website



Upcoming Features for Website

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Caltrans ARS Online

This web-based tool calculates both deterministic and probabilistic acceleration response spectra for any location in California based on criteria provided in *Appendix B of Caltrans Seismic Design Criteria*. More...

SELECT SITE LOCATION

Street View Map Satellite Hybrid



Latitude: Longitude: Vs: m/s **Calculate**

Summary

- Raises situational awareness after earthquake.
- Represents the most reliable information within the first hours following an event.
- Responders get information 10 to 15 minutes following an earthquake via email.



More Information

On the internet:

<http://earthquake.usgs.gov/resources/software/shakecast/>

In print:

Earthquake Spectra, May 2008,
Volume 24, Issue 2

"ShakeCast: Automating and Improving the Use of ShakeMap for Post-Earthquake Decision-Making and Response"



USGS
science for a changing world

USGS ShakeCast

Automating, Simplifying, and Improving the Use of ShakeMap for Post-Earthquake Decisionmaking and Response

ShakeCast is a freely available, post-earthquake situational awareness application that automatically retrieves earthquake shaking data from ShakeMap, compares intensity measures against users' facilities, and generates potential damage assessment notifications, facility damage maps, and other Web-based products for emergency managers and responders.

What is ShakeCast?

ShakeCast, short for *ShakeMap Broadcast*, is a fully automated system for delivering specific ShakeMap products to critical users and for triggering established post-earthquake response protocols. ShakeMap is a well-established tool used to portray the extent of potentially damaging shaking following an earthquake. ShakeMap is automatically generated for small and large earthquakes in areas where it is available and can be found on the Internet at <http://earthquake.usgs.gov/shakemap/>. It was developed and is used primarily for emergency response, loss estimation, and public information. However, for an informed response to a serious earthquake, critical users must go beyond just looking at ShakeMap, and understand the likely extent and severity of impact on the facilities for which they are responsible. To this end the U.S. Geological Survey (USGS) has developed ShakeCast.

ShakeCast allows utilities, transportation agencies, businesses, and other large organizations to control and optimize the earthquake information they receive. With ShakeCast, they can automatically determine the shaking value at their facilities, set thresholds for notification of damage states for each facility, and then automatically notify (by pager, cell phone, or email) specified operators and inspectors within their organizations who are responsible for those particular facilities so they can set priorities for response.

Example Uses and Users: The California Department of Transportation (Caltrans)

Caltrans has deployed the prototype ShakeCast system (Version 1.0). Following a major earthquake, Caltrans faces an array of decisionmaking challenges. Perhaps no other agency has a comparable earthquake exposure in the State of California. Caltrans has more than 11,000 bridges and overpasses under its responsibility in California; having an instantaneous snapshot of the likely damage to each will allow Caltrans to set priorities for traffic rerouting, closures, and inspections following a damaging earthquake. One of several critical tasks facing Caltrans after an earthquake is to rapidly assess the condition of all bridges and roadway corridors in the State highway system. Timely response is important to ensure public safety, aid routing of emergency vehicle traffic, and (re-) establish critical lifeline routes.

U.S. Department of the Interior
U.S. Geological Survey

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