### A ShakeCast User's Observations on the Benefits of Situational Awareness for Seismic Risk Management

Loren Turner Caltrans Division of Research & Innovation

> David Wald Kuo-Wan Lin U.S. Geological Survey



## ShakeCast Overview

- Project History
- What is it?
- What does it provide to responders?
- How does it work?
- How has Caltrans benefitted?

## 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.

## ShakeCast

- Suite of software 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 within 10 to 15 minutes following event
- Provides suite of tools on ShakeCast website





## ShakeCast

Earthquakes Search FAQ Profile Administration Panel Log out [scadmin

Latest Earthquake Earthquake Archive Scenarios

ility Type: All BRIDGE

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Table View

- Provides situational awareness after an earthquake.
- Represents the most reliable information within the first minutes to hours following an event.

CALTRANS SHAKE CAST 2



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### System Overview



# ShakeCast Technologies

- Developed using open-source tools:
  - WAMP stack
    - Windows (Server 2003)
    - Apache
    - MySQL
    - **P**HP
  - Perl
  - Javascript
  - RSS
  - GoogleMaps API
- Stand-alone version can run the stack off a flash drive.





## ShakeCast Products

- Email notification
- ShakeCast Website
- GoogleEarth products
- Other products

# **Email Notifications**

- ShakeMaps available 5–10 minutes after an earthquake.
- "NEW EVENT" messages sent out by ShakeCast as soon as ShakeMaps are generated.
- "BRIDGE ASSESSMENT" messages are sent within 1 minute from receipt of ShakeMaps.
- ▶ 10–15 minutes total.

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ShakeCast Prelin	ninary Ear	thquake Bridge Impact Report
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### 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 Bridg most likely impacted by the event.

Raiston Avenue OC	35 0114	04-SM-101-9.55-BMT	in the second second	105,3903	2.934
Via Del Ore 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	Think	49.6514	2.167
Constitution Way OC	33 0513K	04-ALA-260-R.86-ALA	Han	68.2755	1.415
Meridian Road Underpass	37 0258	04-SCL-280-R3.89-SJS	1040	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	Athen	61.0924	1,064
Stobb-Approach Lower Deck	34 0118R	04-SF-080-4.95-SF	446410	33.2578	1.057
Holly Street OC	35 0037	04-SM-101-8.4	Think	65,904	1,048
Route 13/80 Separation (North)	33 0191G	04-ALA-013-13.92-BER	tean	66.6766	1.046
Race Street Overcrossing	37 0260	04-SCL-280-R3.76-SJS	1than	59.9229	1,045
Presidio Viaduct	34 0019	04-SF-101-9.14-SF	1100	68.3123	1.035
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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	THAD	56.8606	1.018
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N101-S84 Connector OC	35 0081G	04-SM-101-5.39-RDWC	ittan.	56.8606	1.009
N17-N85 Connector Separation	37 0515G	04-SCL-017-9.24-LGTS	19hahr	86.2137	1.008
San Francisquito Creek	35 0013	04-SM-10101	HINK	55.3678	1.007
N&S87-S280 Connector Sonaration	37 0396H	04-SCL-087-5.1-SJS	1000	50.5564	1.001
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Harkins Slough Road OC	36 0080	05-SCR-001-R2 27-WAT	Medium-High	56.0768	0.038
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<loren.turner@dot.ca.gov></loren.turner@dot.ca.gov>	xe
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05/09/2008 11:18 AM	Subject BRIDGE ASSESSMENT 6.9, 7 km NNE of Aptos, CA (Lonsa_Prieta_acte Vers

This report superaucies any actilier reports about this event. This is a computer-generated message and has not yet been reviewed by an Engineer or Seismologit Information about the spiceland, magnitude, location, date, and then are provided by the Cationnia Integrated Seismic Network (CISN). The analysis of potential bridge damage in the reports based upon an initial ShareMap (unversited) and estimated fragilities for Cationan bridge. Engles fragility models were adopted from MAZUS and Based 5 Mandard (1990). This sport is interded to be used as a first response tool to assist in identifying Catirana bridges most likely impacted by the event.



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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: -121.88 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

Calirans ShakeCast Server (C)	To Caltrans-ShakeCartAdminia dot.ca.gov
<loren.turner@dot.cs.gov></loren.turner@dot.cs.gov>	xe
05/0#2008 11:18 AM	box Subject BRIDGE ASSESSMENT: 6.9, 7 km NNE of Aptos, CA (Lona_Print_acte Versic 1)

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Ratston Avenue OC	35 01 14	04-SM-101-9.55-BMT	Hum	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	Think	49.6514	2.167
Constitution Way OC	33 0513K	04-ALA-260-R.86-ALA	Han	68.2755	1.415
Meridian Road Underpass	37 0258	04-SCL-280-R3.89-SJS	Hum	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	Hint	68.3762	1.071
Redwood Creek	35 0145	04-SM-101-6.2-RDWC	Histy	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	Think	65,904	1,048
Route 13/80 Separation (North)	33 0191G	04-ALA-013-13.92-BER	Man	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	1900 D	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	- Hum-	35,1822	1.030
Powell Street UC	33 0020	04-ALA-080-3.79-EMV	Liter.	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-SJ5	1000	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	HILL	86.2137	1,008
San Francisquito Creek	35 0013	04-SM-10101	14100	55.3678	1.007
N&S87-S280 Connector Separation	37 0396H	04-SCL-087-5.1-SJS	Hun	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	87 0263L	04-SCL-280-R3,41-SJS	Medium-High	52,8878	0,909
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#### 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-Hig	jh 👘	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 **1sec Peak** Bridge Inspection Spectral Exceedance Bridge Name Dist-Cty-Rte-PM Acceleration Number Priority Ratio (%g) Ralston Avenue OC 35 0114 04-SM-101-9.55-BMT 105.3903 2.934 Via Del Oro OH 37 0477L 04-SCL-085-1.22-SJS 49.2711 2.472 San Mateo-Hayward Bridge 04-SM-092-R14.44-FSTC 35 0054 49.6514 2.167 Constitution Way OC 33 0513K 04-ALA-260-R.86-ALA 68.2755 1.415 04-SCL-280-R3.89-SJS Meridian Road Underpass 37 0258 59.9229 1,122 Campbell Underpass 37 0135 04-SCL-017-12.22-CMB 70.2112 1.087 East Hillsdale Blvd OC 35 0138 04-SM-101-11 15-SM 68.3762 1.071 Redwood Creek 35 0145 04-SM-101-6.2-RDWC 61.0924 1.064 Sfobb-Approach Lower Deck 34 0118R 04-SF-080-4.95-SF 33.2578 1.057 Holly Street OC 35 0037 04-SM-101-8.4 65.904 1.048 Route 13/80 Separation (North) 33 0191G 04-AI A-013-13 92-BER 66 6766 1 0 4 6 Race Street Overcrossing 37 0260 04-SCL-280-R3.76-SJS 59.9229 1.045 Presidio Viaduct 34 0019 04-SF-101-9.14-SF 68.3123 1.035 South Delaware Street UC 35 0158L 04-SM-092-R11.61-SM 35.1822 1.030 South Delaware Street UC 35 0158R 04-SM-092-R11 61-SM 35.1822 1 0 3 0 Powell Street UC 33 0020 04-ALA-080-3.79-EMV 66.6766 1.020 Redwood Harbor Overhead 35 0065 04-SM-101-5.5-RDWC 56.8606 1.018 Macarthur Avenue OC 37 0100 04-SCL-280-L5.18-SJS 54.4613 1.012 N101-S84 Connector OC 35 0081G 04-SM-101-5.39-RDWC 56.8606 1.009 N17-N85 Connector Separation 37 0515G 04-SCL-017-9.24-LGTS 86.2137 1.008 San Francisquito Creek 35 0013 04-SM-101-.01 55.3678 1.007 N&S87-S280 Connector 37 0396H 04-SCL-087-5.1-SJS 50.5564 1.001 Separation 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-Hiah 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 Gilrov OH Medium-High 37 03051 43 2728 0.896 04-SCL-101-R5.1

### /ictorvi 10Ranch 14 1 nalewo Redondo Beach ©2008 NASA, TerraMetrics, Map date

Responders can use the link in the email to go to the ShakeCast website for additional information.

### Select an earthquake from the last 7 days

#### SUBMIT

#### ShakeCast Summary

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

Earthquake Archive

Scenarios

#### Map View

	M 6.7 -	Chino	Hills Fault Sce	enario (ID: C	Chino_Hills	6.7_se_scte	e - 5)					
	Facil ty ID	Туре	Description	Inspection Priority <b>V</b>	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		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		33,99652901.		. 300	. 35.7487 . Man View	.38.3302	90.7822	. 40 ARAR .	JR 1639
	56 0497	BRIDGE	Magnolia Avenue OC		33.8	200	S		Man	Satollita	Clo	)711
	54 0746	BRIDGE	Monte Vista Avenue OC		34.( 🗲 🛠	· →		ia to	wap	Joalennie		788
	54 0744	BRIDGE	Pipeline Avenue OC		34.0	Par	and the second	Gi Lat: 33.87	reen River D 848421 Lon	rive OC : -117.6578	3573	411
	53 1873	BRIDGE	Prospectors UC		34.0	Stat.	-3	MMI	:	8.56		9044
	54 0745	BRIDGE	Ramona Avenue OC		34.0			PGA	1:  :	40.0934 61.9509		788
	53 1933	BRIDGE	Spadra OH		34.0	PAY BOS	CAL I	PSA0	13: .0:	119.4515		109
	53 2106	BRIDGE	State Street OC		34.0		3	PSA3	0.	19.6343		1234
	53 2078K	BRIDGE	Valley Blvd UC		34.0							962
	53 2078	BRIDGE	Valley Blvd UC		34.0	1 And	1	1	- AY	-	200	962
we	bsite	off	ers diffe	rent w	avs to			1		Riverside	FWV	688
, th	o bri	daa	datauc	ina ma			- 61	TUE	ral e	TEEN RIVEL B	as.	851
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es,	or a	com	ibinatio	n of bo	oth.	าชษาร	- vi	-18:30/0-	-13.2602	42.15/11	14.007511	0.6483

T CALTRANS SHAKE CAST 2



# System Administration

- ShakeCast is administered through a web browser interface.
  - User group accounts.
  - Notification preferences.
  - Notification profiles.
  - Manage processed earthquake events.
  - Facility inventories and fragilities.
  - Server and database settings.



#### Soogle Earth



36°30'12.42" N 117°54'01.39" W

🍣 Google Earth



Newport Avenue OC 34°05'57.67" N 117°16'30.21" W Image © 2008 DigitalGlobe © 2008 Europa Technologies

elev 314 m

Sixth

#### Soogle Earth



In GoogleEarth, other types of realtime data can be brought in. For example, traffic speed data may help verify whether or not a bridge flagged "red" in ShakeCast is actually damaged.

Image © 2008 DigitalGlobe © 2008 Europa Technologies



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#### Soogle Earth

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O VOIN

#### I-10 : E Side Mt Vernon OC

Traffic camera data (if streaming) can also be used as another way to check the ShakeCast information.

OP

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010

For Latest Image At This Location : http://www.dot.ca.gov/dist8/tmc/Cam19.jpg Monday, July 14, 2008 - 10:33:22 PM

832-10/215 HE\_DUAD

Directions: To here - From here



33°58'44.50" N 117°28'49.33" W

241

Riverside Freek

© 2008 Tele Atlas Image © 2008 DigitalGlobe

elev 222 m



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	А	В		С		D	E	F	G	Н	1	J	K	L		٨
1	FACILITY_TYP	E FACILITY	ID FACILI	TY_NAME		LATITUDE	LONGITUDE	INSPECTI	ON MN	1I PGA	PGV	PSA03	PSA10	PSA30		
2	BRIDGE	50 0218	Wheel	er Ridge Road	JOC	34.986	-118.9456	YELLOW		9 23.69	99.6696	28.77	47.03	UNKNOWN		
3	BRIDGE	53 0111	Basset	t OH		34.068	-117.9767	YELLOW	1	40.48	205.5618	51.61	51.6	UNKNOWN		
4	BRIDGE	53 0112	Big Da	lton Wash		34.0	7 -117.9683	YELLOW	1	40.48	205.5618	51.61	51.6	UNKNOWN		
5	BRIDGE	53 0329	Eaton	Wash		34.098	-118.0733	YELLOW	1	38.11	164.9575	53.68	55.38	UNKNOWN		
6	BRIDGE	53 0571L	Rubio	Wash		34.071	7 -118.075	YELLOW	1	38.11	164.9575	53.68	55.38	UNKNOWN		
7	BRIDGE	53 0571R	Rubio	Wash		34.071	7 -118.075	YELLOW	1	38.11	164.9575	53.68	55.38	UNKNOWN		
8	BRIDGE	53 0666	Puente	e Ave UC		34.0	7 -117.96	YELLOW	1	40.48	205.5618	51.61	51.6	UNKNOWN		
9	BRIDGE	53 0667	Camer	on Ave UC		34.071	7 -117.945	YELLOW	1	41.26	174.701	55.35	60.91	UNKNOWN		
10	BRIDGE	53 0668	Sunset	t Ave UC		34.073	3 -117.935	YELLOW	1	41.26	174.701	55.35	60.91	UNKNOWN		
11	BRIDGE	53 0771	Third S	Street UC		34.033	3 -118.1817	YELLOW		9 18.85	97.676	27.92	25.09	UNKNOWN		
12	BRIDGE	53 0867	East El	Monte OH		34.068	3 -118.0217	YELLOW	1	33.84	183.0013	37.94	51.49	UNKNOWN		
13	BRIDGE	53 1032	Garvey	Ave Off-Ram	np UC	34.06	5 -118.0083	YELLOW	1	38.08	207.4693	50.59	54.47	UNKNOWN		
14	BRIDGE	53 1043	Vincer	nt Ave UC		34.071	7 -117.925	YELLOW		9 27.97	112.7944	50.51	31.85	UNKNOWN		
15	BRIDGE	53 1115	Roxfor	d Street UC		34.303	3 -118.4783	YELLOW		9 21.71	84.9497	28.83	33.19	UNKNOWN		
16	BRIDGE	53 1130	Brand	Blvd UC		34.273	3 -118.4483	YELLOW		9 23.36	87.4812	31.27	34.75	UNKNOWN		
17	BRIDGE	53 1131	San Fe	rnando Missio	on B U	34.276	7 -118.4517	YELLOW		9 21.71	84.9497	28.83	33.19	UNKNOWN		
18	BRIDGE	53 1132	Rinald	i Street UC		34.278	3 -118.4533	YELLOW		9 21.71	84.9497	28.83	33.19	UNKNOWN		
19	BRIDGE	53 1220	Chatsv	vorth Dr UC		34.273	3 -118.4483	YELLOW		9 23.36	87.4812	31.27	34.75	UNKNOWN		
20	Shake	Cast	auton	naticall	v aer	nerateg	. 7	YELLOW		9 23.01	81.4418	42.33	37.69	UNKNOWN		
21		.Cust		i acican	ygci		<b>'</b> 3	YELLOW	1	60.73	191.9317	115.33	75.17	UNKNOWN		
22	Excel	sprea	dshee	ets with	1 the	bridge	2 3	YELLOW	1	60.73	191.9317	115.33	75.17	UNKNOWN		
23	data f	or us	o in o	ther pr	nces		7	YELLOW	1	10 58.95	191.2057	145.53	65.04	UNKNOWN		
24	uata i	UI US		the pi	UCC3.	503.	7	YELLOW	1	58.95	191.2057	145.53	65.04	UNKNOWN		
25	BRIDGE	53 1440L	Anave	rde Creek		34.573	3 -118.1317	YELLOW	1	10 58.95	191.2057	145.53	65.04	UNKNOWN		
26	BRIDGE	53 1440R	Anave	rde Creek		34.573	3 -118.1317	YELLOW	1	10 58.95	191.2057	145.53	65.04	UNKNOWN	<b>_</b>	
27	BRIDGE	53 1546	Ward F	Road OC		34.501	7 -118.2283	YELLOW		9 30.62	79.985	70.71	36.11	UNKNOWN		
Dep	dy 💌	ure 🖓										1 100	1%			J
Aca	u)											100		$\sim$	E	

## Foundation for ShakeCast



### California Integrated Seismic Network (CISN) ShakeMaps are generated from a statewide array of strong motion





# **Bridge Fragility**

- Bridge fragility method is based upon work originally published by Basöz and Mander.
- Method was implemented in FEMA's HAZUS-MH software.
- Uses data from National Bridge Inventory (NBI) as inputs:
  - Year built
  - Year improved or retrofit
  - Angle of skew
  - Bridge type
  - Number of spans
  - Maximum span length
  - Total bridge length
    - Deck width



## **Bridge Fragility**

HAZUS Damage State	Definitions of HAZUS Damage States (FEMA 2009)	ShakeCast Inspection Priority	Definition of ShakeCast Inspection Priority
Complete (ds5)	ds5 is defined by any column collapsing and connection losing all bearing support, which may lead to imminent deck collapse, tilting of substructure due to foundation failure.	High	High Priority for full engineering assessment
Extensive (ds4)	ds4 is defined by any column degrading without collapse – shear failure - (column structurally unsafe), significant residual movement at connections, or major settlement approach, vertical offset of the abutment, differential settlement at connections, shear key failure at abutments.	Medium-High	Medium-High Priority for full engineering assessment
Moderate (ds3)	ds3 is defined by any column experiencing moderate (shear cracks) cracking and spalling (column structurally still sound), moderate movement of the abutment (<2"), extensive cracking and spalling of shear keys, any connection having cracked shear keys or bent bolts, keeper bar failure without unseating, rocker bearing failure or moderate settlement of the approach.	Medium	Medium Priority for full engineering assessment
Slight/Minor (ds2)	ds2 is defined by minor cracking and spalling to the abutment, cracks in shear keys at abutments, minor spalling and cracks at hinges, minor spalling at the column (damage requires no more than cosmetic repair) or minor cracking to the deck		
		Low	Low Priority for full engineering assessment; quick visual inspection likely sufficient. (1.0 second peak spectral acceleration exceeds 0.10g.)
None (ds1)			

# **Bridge Fragility**

- Filemaker Pro software is used to calculate bridge fragility parameters.
- Calculations are revised annually as the bridge inventory changes.
- New fragility parameters are ported to the ShakeCast MySQL database annually.

Maker Pro Advan	ced - [Bridge Inventory 090208]					
Edit View Insert	Format Records Scripts Tools Window Help					
		* Q				
e						
💾 Bridge Dat	ta from SMART	Bridge Design Assessmer	nt			
BRKEY	56 0505	Materialappr	· 1	Material Concrete		
Strucname	SANTA MARIA ROAD OC	Designappr	0	Design Other		
District	8					
Co	RIV	Materialmain	i 1	Material Concrete		
F Rte	215	Designmain	2	Design Stringer/Mult	ti-beam or Girder	
PM	R038.920					
Location	08-RIV-215-R38.92-RIV	NBI Clas	s 102		Yearbuilt 1966	
		HAZUS Classification (if Conventiona	I) HVVB6	Y	earrecon U	
Length	64.3	HAZUS Classification (if Seismi H97US Classification (if no NPL Classification)	c) r10007	Rebuilt_widen_	etc. date U	
Facility	SANTA MARIA ROAD	HAZUS Classification (if Single Spar	-, -)	Phase 2 PS F Ret	ofit Date 0	
Featint	RUUTE 215	HAZUS Classification (if Max Span>150n	n)	Year of Most Recent Imp	rovement 1966	
Perior	6 Decigo Live Lood HS 20+Mod	HAZUS Classification (if Max Span<20n	n)	Seismi	o Design N	
Iffourbsw	n					
Rtcurbsw	1.5	Location Data				
Deckwidth	14.4	SMODT 1 -+	33 9483000	CMODT	Lop -117 3000000	
Volrunder	4.55	TASAS latitude	33,9481940	TASAS Longi	tude -117.3013900	
Trafficdir	2	Latitude Updated	33.9481940	Longitude Upo	lated -117.3013900	
Skew	0					
Mainspans	2	Formatted Bridge Name a	nd Descripti	on		
Appspans	2	Formatted Structure Name	56 0505 - SAN	ITA MARIA ROAD OC		
maxspart	23	Bridge Description	2-span: Concr	rete: Stringer/Multi-beam	n or Girder	
Lanes on	2					
Lanes_under	6	Owner	State			
Strflared	0					
Dkrating	7	1147UC Exemility Coloulatio				
Suprating	7	HAZOS Fragility Calculatio	ns			
Subrating		FINAL HAZUS Classification	HWB6 Multi Col. Doi:	nt Dimenia Ournaut Ori		
Culvrating	1	Description	FO1	ni, aimple support - Cor	Icrete	
Ortope	47.9	NoD Equation	1 250			
Intype	1	Ishape	0			
Irioad	28.8	Kskew	1.000			
Strrating	7				Bridge Fragi	lity (%a)
Deckgeom	6		0.50		bridge Fragi	10 00
Dkmembtype	0	1 sec SA Moderate	06.0		Modified 1 sec SA DS2	62.50
Dkprotect	0	1 sec SA Extensive	0.90		Modified 1 sec 58 DS3	75.00
Dkstructyp	1	r seo ox comprete	0.00		Modified 1 sec SA DS5	112.50
Dksurftype	5/28/2008					
Lasi opdate	3/20/2000					
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## Caltrans-ShakeCast Usage

- ▶ 350+ current subscribers to ShakeCast
  - Structures Maintenance & Investigations
  - Earthquake Engineering
  - Post EQ Investigations Team
  - Structures Construction
  - Geotechnical Services Office Chiefs
  - Traffic Management Centers
  - Mid/Upper Caltrans Management
- ShakeCast is now an integral component of Caltrans' response protocol

### Golden Guardian November 2008

and the second se		CALTRANS SHAKE CAST 2	
Home Earthquakes Search FAQ Profile A Latest Earthquake Earthquake Archive	Ministration Panel L Loc out Escedinin 1 Bridge Assessment Summary Maximum Peak 1.0 sec Spectral Acceleration: 273.702%g Maximum Acceleration: (not measured) Total number of bridges assessed: 5012 Summary by inspection priority:		
Table View Google Maps for ShakeMap ShakeOu Facility Type: All	High 49 Medium-High 130 Medium 109 Low 4724	High Priority for full engineering assessment Medium-High Priority for full engineering assessment Medium Priority for full engineering assessment Low Priority for full engineering assessment; quick visual inspection likely sufficient.	
<ul> <li>Annotation</li> <li>Annotation</li></ul>	Adelanto	Map Satellite Hybrid Statellite	
Ami Valley	ShakeCast to carry out the scenario.		
	Highor Yu	caipa Dept Hot Paints 53 2648S - SKYL INF	

### 5.4 Chino Hills July 2008

Grier St. POC on Route 71 Bridge 53-1158 7/30/08



### Bridge Assessment Summary

Maximum Peak 1.0 sec Spectral Acceleration: 34.7183%g Maximum Acceleration: (not measured) Total number of bridges assessed: **468** Summary by inspection priority:

High	NULL	High Priority for full engineering ass
Medium-High	NULL	Medium-High Priority for full enginee
Medium	NULL	Medium Priority for full engineering
Low	468	Low Priority for full engineering asse

### **Bridge Assessment Details**

Bridges presented in the table below are sorted in order of severity of impact (exceedance ratio). The list includes

Bridge Name	Bridge Number	Dist-(
53 2078 - VALLEY BLVD UC	53 2078	07-LA
53 2078K - VALLEY BLVD UC	53 2078K	07-LA
53 1158 - GRIER STREET POC	53 1158	07-LA
53 2107 - TEMPLE AVENUE OC	53 2107	07-LA

ShakeCast identified the only bridge damaged in this event as the 3<sup>rd</sup> highest priority for inspection.

SPEED

### 7.2 Calexico April 2010

Sun Apr 4, 2010 03:40:40 PM PDT M 7.2 N32.13 W115.30 Depth: 10.0km ID:14607652 33.5°

CISN ShakeMap : 39.0 mi SSE of Calexico, CA

•San Luis R

•Guadalupe Victoria

ShakeCast identified the only bridge damaged in this event as the top priority for inspection.

High

Medium-High Medium Low

### Bridge Assessment Summary

Maximum Peak 1.0 sec Spectral Acceleration: 48.5782%g Maximum Acceleration: (not measured) Total number of bridges assessed: **219** Summary by inspection priority:

NULL	High Priority for full engineering assessment
NULL	Medium-High Priority for full engineering asses
NULL	Medium Priority for full engineering assessmen
219	Low Priority for full engineering assessment; qu

### **Bridge Assessment Details**

Bridges presented in the table below are sorted in order of severity of impact (exceedance ratio). The lis Acceleration exceeds 10% g.

Bridge Name	Bridge Number	Dist-Cty-Rte-PM
58 0274 - WESTSIDE MAIN CANAD	58 0274	11-IMP-098-22.02
58 0275 - WORMWOOD CANAL	58 0275	11-IMP-098-22.07
58 0212L - COYOTE WELLS OH	58 0212L	11-IMP-008-R13.97
58 0212R - COYOTE WELLS OH	58 0212R	11-IMP-008-R13.93



The Professional Journal of the Earthquake Engineering Research Institute



managers and responders. Cast, short for ShakeMap Broadcast, is a fully auto-What is ShakeCast? tished tool used to **VOLUME 24, NUMBER 2** 

ShakeMap for Post-Earthquake Decisionmaking habeCast is a freely available, post-earthquake situalional awareness application that automatically and Response retrieves earthquake shaking data from ShakeMap. compares intensity measures against users' facilities, and compares measury measures against users menures, and generates potential damage assessment notifications, facility generates potential onmage assessment nonrications, factory damage maps, and other Web-based products for emergency

SGS ShakeCast Automating, Simplifying, and Improving the Use of

nce for a cha



Caltrans Deploys a Tool for Rapid Postearthquake Response LOREN L. TURNER, DAVID WALD, AND KUO-WAN LIN fter a major carthqualor, one of the most critical tasks for the California Department of Immeportation (Caltrane) is to assess the impact on the condition of all bridges and roadway corridors in the state highway system. Timely response ensures public safety, guides emergency which traffic, and reestablishes critical

ShakeCast

Geophysicist and Lin is a

M.EERI, and Loren Turner<sup>c)</sup>

Problem

RESEARCH PAYS OFF

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Carbans .

Pich & Inno

Tarver is Senior

Transportation Engineer.

California Department of

Transportation\_Division

Innovation, Sacramento;

Wald is a Supervisory

Geophysicist with the

U.S. Geological Sarvey

Golden, Colorado,

Immediately after an earthquake, bridge inspection

data and analyzes the data in relation to individua bridge performance characteristics. Within minutes

of an event, the program generates e-mails to set pro-

critics for impection and seembles other web-based products to series emergency responders. StoleCast we built on ShakeMap, a USGS product that receives measured ground motion data from

a network of more than 1,000 sensors throughout California approximately two-thirds of all sensors nationwide and combines the information with geo. ShakeCast: Automating and Improvid

the Use of ShakeMap for Post-Earthd

David Wald,<sup>a)</sup> M.EERI, Kuo-Wan Lin,<sup>a)</sup> Keith Porter,<sup>b)</sup> When a potentially damaging earthquake occurs utility managers, emergency responders and other for information about the immediate appropriate desision

Decision-Making and Response

### A ShakeCast User's Observations on the Benefits of Situational Awareness for Seismic Risk Management

Loren Turner Caltrans Division of Research & Innovation

> David Wald Kuo-Wan Lin U.S. Geological Survey

