

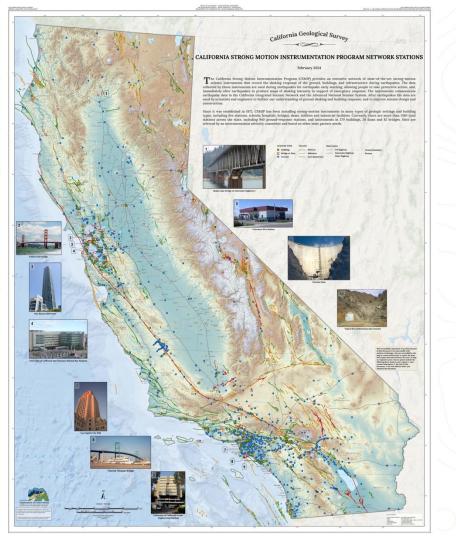
### Updates on California Strong Motion Instrumentation Program (CSMIP)

Hamid Haddadi California Strong Motion Instrumentation Program (CSMIP) California Geological Survey (916) 416 8047 hamid.haddadi@conservation.ca.gov

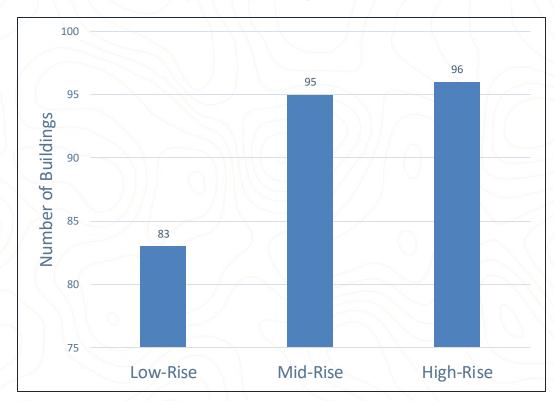
### **CSMIP** Active Stations

### 1384 active stations (>10,000 sensors) including:

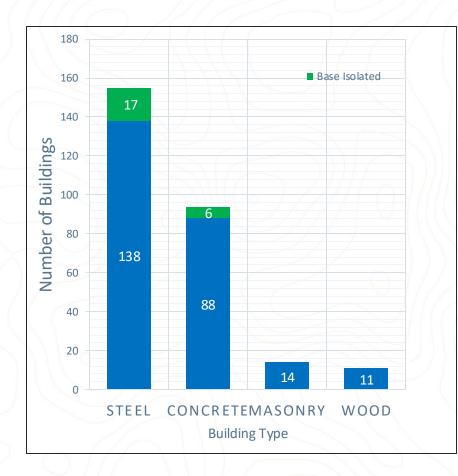
- 940 Ground Response Stations
- 274 Buildings
- 128 Lifelines
- 42 Geotechnical Arrays



### CSMIP Instrumented Buildings by Height (274 Buildings)



### **CSMIP Instrumented Buildings by Types**



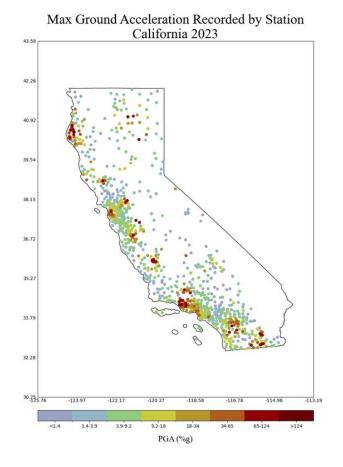
### Strong-Motion Data at CESMD



Maximum ground shaking recorded at strongmotion station during 2023 from 377 California earthquakes.

Data are posted at the CESMD





# Shaking Intensity Over 42 Years in California

Post Offices to Pixels: The Evolution of Earthquake Intensity Mapping

CALIFORNIA GEOLOGICAL SURVEY JEREMY LANCASTER, STATE GEOLOI

> Historically, shaking intensities were derived in the months following an carthquake through questionnaires sent to post offices in the impacted area. Postal officials were asked to report the effects of shaking in their district and their observations were combined with those of scientists and engineers. When all the questionnaires and observations were combined, they were used to construct an intensity map of the carthquake. Now, with California's extensive seisongraphic network, intensity maps (Shake Mapo) can be automatically generated within innuites of an earthquake.

# California Geological Survey

#### SHAKING INTENSITY OVER 42 YEARS

A CUMULATIVE SHAKEMAP OF CALIFORNIA FROM 1981 TO 2023

Modified Mercalli Intensity (MMI) Scale

STATE OF CALIFORNIA - GAVIN NEWSOM, GOVERNO

Intensity	1	11-111	IV	v	VI	VII			
Shaking	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
Damage	None	None	None	Very light	Light	Moderate	Moderate/ Heavy	Heavy	Very heavy

HIS MAP COMPILES ALL SHAKEMAPS GENERATED FROM 1981 TO 2023 for earthquakes of magnitude 40 and above. A ShakeMap is a representation of ground shaking produced by an earthquake. Specifically, ShakeMaps depict peak intensities of ground motions-acceleration and velocity-measured and recorded by esimographs.\*

> ShakMaps are useful in emergency response because they portray the potential effects of architopake shaking in a particular location. These effects can include human casualtes, damage to lifelines, and how the earthquake was perceived by people in the impacted area. The effects of shaking on topography are also a feature of intensity, whether, for example, cracks, displacements, liquefaction, or landshides may have occurred.

> > \*Occasionally, measured ground motion intensities are suppler openitness reports. Also, in areas where data are limited, y equations are used to estimate intensities.

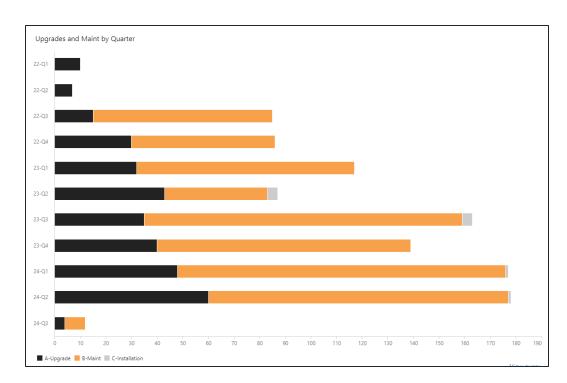
> > > Department of Conservation

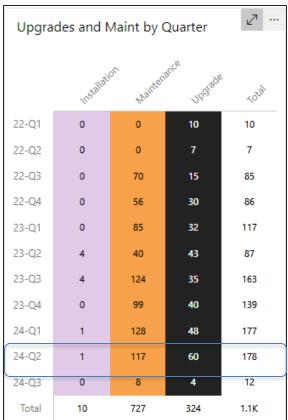


# Statewide Strong-Motion Instrument Upgrades Project



# Instruments Upgrade, Maintenance, and New Installation (since Jan 2022)





California Department of Conservation | conservation.ca.gov



### **Buildings Re-instrumentation**

72 buildings were planned to get re-instrumented

Phase 1: More extensive instrumentation of 49 buildings: 5 completed

Phase 2: Instrumentation of the remaining 23 buildings

### Lancaster Airport Control Tower CSMIP Station #24474





Palm Desert – Kiewit Building CSMIP Station #12284



### Lancaster – Medical Office Building CSMIP Station #24517



### Los Angeles – 311 S. Spring Street CSMIP Station #24567



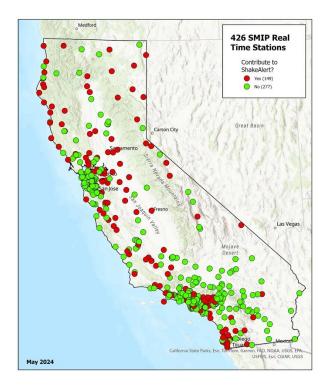
### Pasadena – Mutual Savings Bldg. CSMIP Station #24571



### **CSMIP Stations Operating in Real Time**



- Currently 426 CSMIP stations operate in real time.
- 277 stations supported by CEEWS
- 149 out of 277 stations contribute to ShakeAlert
- Realtime Shaking Map





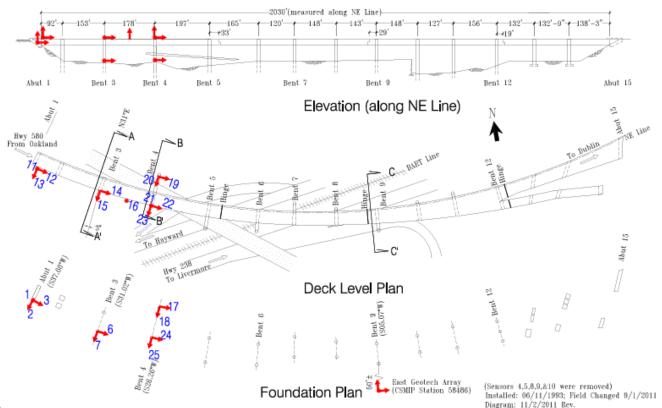


Hayward - Hwy 580/238 Interchange Bridge Caltrans Bridge No.33-214-I (04-ALA-580-30.80)

Page 1 of 2

CSMIP Station No. 58658





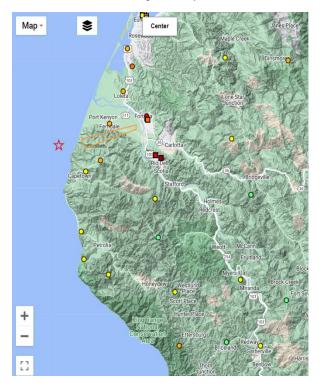
# Hayward -Hwy 580/238 Records in CESMD

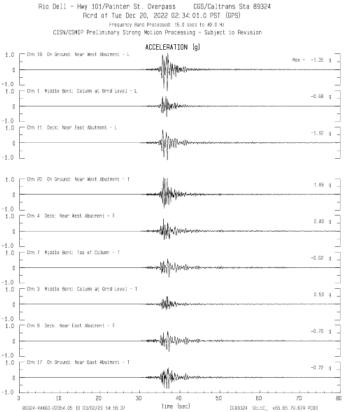


StaNo ▼	Station	Network	Epicentral Distance (km)	Fault Distance (km)	Ground pga (g)	Struct pga (g)	Earthquake Name	Magnitude	Earthquake Origin Time(UTC)	Event ID	View	Download
58658	<u>Hayward - Hwy</u> 580/238 Interchange Bridge	CGS	91.7	-	0.014	0.015	Gilroy	4.9MI	2002-05-14 05:00:29	nc40133364	0	
58658	<u>Hayward - Hwy</u> 580/238 Interchange Bridge	CGS	23.3	-		0.055	Lafayette	4.2ML	2007-03-02 04:40:00	nc40194055	0	
58658	<u>Hayward - Hwy</u> 580/238 Interchange Bridge	CGS	21.5	-		0.027	Alamo	4.0Mw	2008-09-06 04:00:15	nc51207740	0	
58658	<u>Hayward - Hwy</u> 580/238 Interchange Bridge	CGS	22.7	-	0.039	0.040	berkeley	4.4MW	2018-01-04 10:39:37	nc72948801	0	
58658	<u>Hayward - Hwy</u> 580/238 Interchange Bridge	CGS	2.7	-	0.074	0.142	SanLorenzo	3.9MW	2021-06-29 01:29:48	nc73580646	0	
58658	<u>Hayward - Hwy</u> 580/238 Interchange Bridge	CGS	15.9	-	0.034	0.028	SanRamon	3.9MW	2021-11-17 19:43:43	nc73654060	0	
58658	<u>Hayward - Hwy</u> 580/238 Interchange Bridge	CGS	5.2	-	0.020	0.020	SanLeandro	3.1ML	2022-02-07 00:01:53	nc73689506	0	
58658	<u>Hayward - Hwy</u> 580/238 Interchange Bridge	CGS	6.9	-	0.007	0.016	SanLeandro	3.2MW	2022-02-12 03:13:42	nc73691736	0	
58658	<u>Hayward - Hwy</u> 580/238 Interchange Bridge	CGS	7.6		0.008	0.021	SanLeandro	3.0ML	2023-04-01 16:43:48	nc73865505	-	



### M6.4 Ferndale Earthquake of Dec 20, 2022 Rio Dell – Hwy 101/Painter St.





# Fernbridge Seismic Gate



Constructed in 1911

Connects Fernbridge community to Ferndale

In 1976, the American Society of Civil Engineers designated Fernbridge as an historic civil engineering landmark





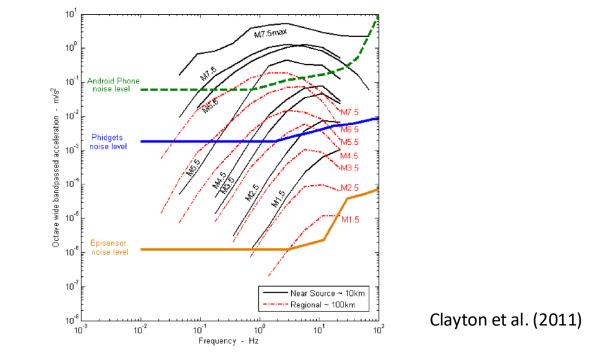
# Fernbridge Seismic Gate





### **Application of High vs Low Resolution Accelerometers**

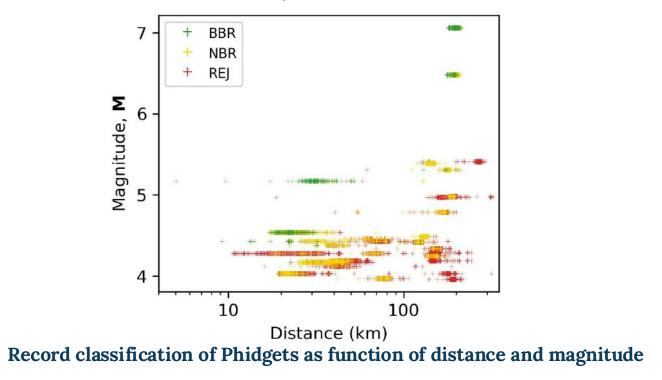




Noise level of MEMS accelerometers (Phidgets) as compared to cell phone and episensor accelerometers



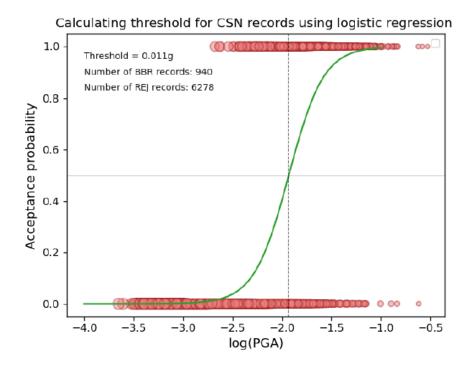
# Useability of CSN Data



CSMIP Data Utilization Project, Stewart et al. (2023)

# Useability of CSN Data





Data and binary logistic regression fit for acceptance (BBR) and rejection (REJ) of CSN data as function of log(PGA)

CSMIP Data Utilization Project, Stewart et al. (2023)

### Evaluate Usability of Lower Cost/Resolution Instruments A project of CGS and CalOES with Caltech/UCLA



### Collocated CSN at 10 Ground Response Stations and one High-Rise Building



Evaluate Usability of Lower Cost/Resolution Instruments A project of CGS and CalOES with Caltech/UCLA

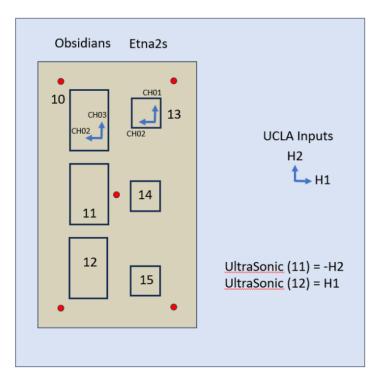


Shake Table test at UNR: July 2024

- > Shake Table test in Spring 2025 at UC San Diego
- HCAI wood-frame hospital instrumentations: collocate high- and low-resolution instruments

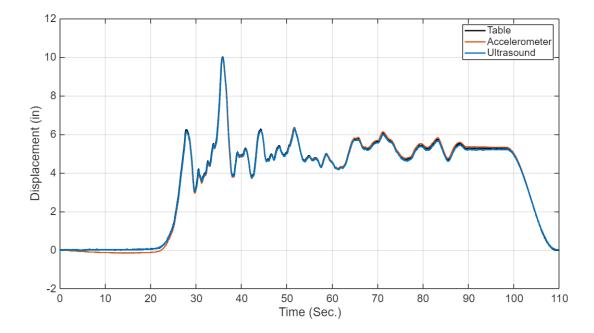


#### Evaluate Usability of Lower Cost/Resolution Instruments Shake Table Test





#### **Residual Displacement Measurement - Shake Table Test**





#### **CSMIP Data Utilization Projects**

Year	PI	Institution	Project Title	Remarks
Ground Resp	onse			
2022	Kim Olsen	California State University, San Diego	Calibration of the Near-surface Seismic Structure in the SCEC Community Velocity Model Version S	Contract executed in December 2022
2023	Norm Abrahamson	University of California, Berkeley	Development of a Period-Dependent Duration Model for California	Contract executed in May 2024
2023	Eduardo Miranda	Stanford University	Effect of focal mechanism on the directionality of horizontal ground motion intensity	Contract executed in March 2024
2023	Jonathan Stewart	University of California, Los Angeles	Application of HVSR for Ergodic Site Response Modeling in California	Contract executed in April 2024
Building Res	oonse			
2022	Khalid Mosalam	University of California, Berkeley	Structural Response Prediction Using Deep Neural Networks	Contract executed in December 2022
2022	Dennis Bernal	Northeastern University	Inherent Damping During Nonlinear Seismic Response	Contract executed in January 2023
Lifeline Resp	onse			
2023	Tracy Becker	University of California, Berkeley	Seismic performance of bridges with pier walls	Contract executed in November 2023

# Join CSMIP 2024 Seminar on October 17th



# **THANK YOU**