NSMP Has Over 1300 Seismic Recorders
Freefield and reference sites
485 sites (238 dialup, 96 real time, 151 no telecomm)
Building structures
160 arrays, 250 recorders

USGS NP-7010
WA: Seattle - Crowne Plaza Hotel

USGS NP-8040
AK: Anchorage - Robert B. Atwood Building
NSMP INSTALLATION TYPES

Bridges and highway overpasses
17 arrays, 39 recorders (4 dialup, 3 realtime)
Dams

75 arrays, 237 recorders (32 dialup)
PARTNER AGENCIES

- U.S. Army Corp of Engineers (ACOE)
- U.S. Department of Veterans Affairs (VA)
- Oregon Department of Transportation (ODOT)
- University of Puerto Rico (UPR)
- U.S. General Services Administration (GSA)
- NASA, Jet Propulsion Laboratory (JPL)
- Los Angeles Department of Public Works (LDPW)
- California Department of Water Resources (CDWR)
- Metropolitan Water District of Southern California (MWD)
- Imperial County (CA) Landfill (ICL)
- County and City of San Francisco (CCSF)
- University of Alaska (UAA and UAF)
- Utah, Salt Lake City Corporation (SLCC)
- University of California, Los Angeles (UCLA)
- Utah Department of Transportation (UDOT)
- Brigham Young University (BYU)
- Utah Geological Survey (UGS)
- Washington Department of Natural Resources (WDNR)
To facilitate research studies to understand dynamic of structures, soil structure interaction effects.

- Free field sites.
- Downhole arrays.
- Direct displacement recording through GPS antennas.
- Rotational sensors to record rotational components.
- Continuous or trigger recording
State-of-the-Art Building Instrumentation Funded by ANSS—
Records Building Shaking and Immediate Ground Motion on the Surface and Downhole*

*OBJECTIVE: TO STUDY EFFECT OF LOCAL SITE CONDITIONS ON THE SHAKING OF THE BUILDING
THE NEW FEDERAL BUILDING IN SAN FRANCISCO, CA—
A MODERN STRUCTURE DESIGNED WITH
STATE-OF-THE-ART SEISMIC
DESIGN FEATURES*
BUILDING INSTRUMENTATION

In Cooperation with the City of San Francisco, California

MOSCON CENTER WEST

INSTRUMENTATION DEPLOYED IN THIS BUILDING

NEW TECHNOLOGY—COUPLED GIRDER MOMENT RESISTING FRAME (CGMRF)

(Courtesy of Structural Design Engineers, Inc., San Francisco, CA)

(Note: Triaxial sensor (channels 1,2 and 3) to be located in basement—in electrical room floor.)
RETROFITTED BY BASE ISOLATION—
THE HISTORIC COURT OF APPEALS BUILDING IN SAN FRANCISCO, CA

INSTRUMENTED STRUCTURES: SAN FRANCISCO
# Tall Buildings: USGS

<table>
<thead>
<tr>
<th>Building</th>
<th>General Information</th>
<th>Technical Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transamerica Pyramid</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1100 Wilshire</strong></td>
<td><strong>Location</strong>: 1100 Wilshire Boulevard, Los Angeles, California</td>
<td><strong>Height</strong>: 260 m (850 ft)</td>
</tr>
<tr>
<td></td>
<td><strong>Coordinates</strong>: 34.0522°N 118.2638°W</td>
<td><strong>Floor area</strong>: 35,262 m²</td>
</tr>
<tr>
<td></td>
<td><strong>Status</strong>: Complete</td>
<td><strong>Floor count</strong>: 37</td>
</tr>
<tr>
<td></td>
<td><strong>Constructed</strong>: 1987</td>
<td><strong>Companies involved</strong>: Minoru Yamasaki</td>
</tr>
<tr>
<td></td>
<td><strong>Opening</strong>: 1987</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Use</strong>: Residential</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Century Plaza Towers I &amp; II</th>
<th>General Information</th>
<th>Technical Details</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Location</strong>: 2029 and 2049 Century Park East, Century City, California</td>
<td><strong>Height</strong>: 571 ft (174 m)</td>
</tr>
<tr>
<td></td>
<td><strong>Coordinates</strong>: 38.6277°N 90.1946°W</td>
<td><strong>Floor count</strong>: 44</td>
</tr>
<tr>
<td></td>
<td><strong>Status</strong>: Complete</td>
<td><strong>Floor area</strong>: 1,400,000 square feet (130,000 m²)</td>
</tr>
<tr>
<td></td>
<td><strong>Groundbreaking</strong>: 1969</td>
<td><strong>Cost</strong>: $150 million</td>
</tr>
<tr>
<td></td>
<td><strong>Constructed</strong>: 1975</td>
<td><strong>Companies involved</strong>: Hellmuth, Obata &amp; Kassabaum</td>
</tr>
<tr>
<td></td>
<td><strong>Opening</strong>: 1975</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Use</strong>: Office</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>One AT&amp;T Center</th>
<th>General Information</th>
<th>Technical Details</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Location</strong>: 909 Chestnut Street, St. Louis, Missouri</td>
<td><strong>Height</strong>: 179m/588 feet m[1]</td>
</tr>
<tr>
<td></td>
<td><strong>Coordinates</strong>: 38.6277°N 90.1946°W</td>
<td><strong>Floor count</strong>: 44</td>
</tr>
<tr>
<td></td>
<td><strong>Status</strong>: Complete</td>
<td><strong>Floor area</strong>: 1,400,000 square feet (130,000 m²)</td>
</tr>
<tr>
<td></td>
<td><strong>Construction</strong>: 1966</td>
<td><strong>Cost</strong>: $150 million</td>
</tr>
<tr>
<td></td>
<td><strong>Use</strong>: Office</td>
<td><strong>Companies involved</strong>: Hellmuth, Obata &amp; Kassabaum</td>
</tr>
<tr>
<td></td>
<td><strong>Opening</strong>: 1967</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Use</strong>: Office</td>
<td></td>
</tr>
</tbody>
</table>

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*Sources*: USGS, various architectural websites.
NSMP PRODUCTS

• Time series
  – Corrected (baseline removal, acausal bandpass filter)
    
    Acceleration
    Velocity
    Displacement

• Peak motions (→ ShakeMap)
  – PGA, PGV, PSA at 0.2, 1 and 3.0 sec

• Response Spectra
DATA DISSEMINATION

- Center for Engineering Strong Motion Data (CESMD)
  Cooperative effort with the CGS Strong Motion Instrument Program
  (http://www.strongmotioncenter.org)

- National Engineering Strong Motion Program
  (http://nsmp.wr.usgs.gov)
Seismic Instrumentation of Hospitals

Los Angeles Sepulveda VA Building 10 (completed)

Sensor layout shows locations of 24 channels in the building and associated free-field site

Photo shows areal view of 3 story structure

Photo shows 24-channel recorder installed at the basement in the IT room

The information available online at:
www.strongmotiondatacenter.org
Automated Damage Alerting System

- Local server and LCD display for real time data processing and information broadcasting for building management.
- Web-based continuous health status monitoring
- Real time damage alerting system (Notifications: e-mail, SMS message)
- Earthquake early warning
Local Display for Health Status Information

- Floor may experienced damage
- Different views of the structure
- Real time data stream from select floors

NESMP Monitoring
San Gabriel V.A. Hospital

- Region: Southern California
- GPS: Thu Oct 29 01:07:58 UTC 2009
- Instrument voltage constant at 12
- 200 Samples Per Second
- 8 Sensors
- GPS lock, 7 satellites acquired
WARNING: Floor 8 drift thresholds exceeded
- STT values, buffer length
- Trigger module reported triggering

Click on the icons here to check different views.
WEB BASED Snapshot Viewer [Mock-Up] 20091111 for the period of time during this trigger only

National Strong Motion Program - Real Time Structural Health Monitoring

San Gabriel V.A. Hospital System Status: Alarmed
WARNING: Floor 8: drift thresholds exceeded
Region: Southern California
GPS: Thu Oct 29 01:07:08 UTC 2009
Instrument voltage constant at 12
200 Samples Per Second
8 Sensors
GPS lock; 7 satellites acquired
ST/ST values, buffer length
2 trigger modules reported triggering
USGS/NSMP will maintain system integrity and its health in real time and keep updates.

USGS/NSMP will also maintain the recording units (periodic battery changes – firmware updates)
To ease structural instrumentation
Eliminate cabling
Minimize long term maintenance
New ANSS Instrumentation Project:
AON CENTER – Los Angeles Downtown

- Second-tallest building in LA.
- 90th-tallest building in the world, 30th-tallest building in the United States.
- 858 feet (262 meters) high, and has 62 floors.
- 36+ channels for instrumentation.
New ANSS Instrumentation Project: COLOMBIA CENTER
Seattle Downtown

- Tallest skyscraper in Seattle.
- 937 feet (285 m), 76 stories of office space above ground and seven stories of various use below ground.
- 36+ channels for instrumentation.
Questions...