Frequently Asked Questions About Strong Motion

What is an accelerometer? An accelerograph? And what is an accelerogram?

An accelerometer is a sensor that measures acceleration, like a speedometer measures speed. An accelerometer is often part of an accelerograph, an instrument that contains accelerometers and records the acceleration. The acceleration record is called an accelerogram. (Note the parallel to the more familiar telegraph, an instrument, which produces a record, called a telegram.)

What is acceleration? What does "g" stand for?

Acceleration, in physics, corresponds to the force applied to something that causes it to change its position or speed. It is the force you feel when a car accelerates from a stop sign, pushing you back into the car seat (it's a horizontal force). Similarly, when an elevator starts moving, you feel more weight on your legs (it's a vertical force). When a roller coaster car makes a hairpin turn, the acceleration may push you to the side, or up or down.

Acceleration is often measured in units of "g", where 1 g corresponds to the vertical acceleration force due to gravity. For reference, roller coasters experience accelerations of 2 or more g, and fighter pilots may have to handle accelerations of 8g or more without passing out.

During an earthquake, the forces vary a lot and keep changing, back and forth and side to side. These forces, if they're strong enough, can damage structures unless the structures have been specially designed. The largest earthquake forces that have been measured are about 1 to 2 g; most earthquakes have much lower forces, but those forces can still damage many structures.

What does strong motion mean?

The motion of a point on the ground during a small or distant earthquake can be so small that only specialized, precision instruments can record it. When the earthquake is larger (or closer), that motion will be larger. When the motion reaches the level where humans can feel it, typically a 1-2 %g, it is often called strong motion. This is an actually an arbitrary level, meant to communicate the level qualitatively, as when one says "heavy rain" vs. "light rain".

What other sensors besides accelerometers are used to measure earthquake motion?

The most common sensor is not the accelerometer, which measures acceleration, but the seismometer, which measures the velocity or speed of a point on the ground as it moves during earthquake shaking. Most velocity sensors are high precision, sensitive instruments designed to record motions from distant earthquakes rather than the strong shaking that occurs near earthquakes. Another instrument is the displacement sensor, which can be used in certain applications; in strong motion, they are most useful in measuring relative displacement (the distance between two points). Finally, GPS position sensing has become available and can be used to track the position of a point. Earthquake forces changes so rapidly during an earthquake that they must be measured many times each second (as many as 200). GPS doesn't measure changes that rapid, but is ideal to get final locations once the earthquake is over.

Why do you measure acceleration, instead of velocity, or displacement?

Acceleration gives the forces directly, so it can be used to establish the forces that a structure experiences during an earthquake. Also, acceleration sensors are generally the hardiest of all seismic sensors. In addition, they are usually small, only a few inches on a side, so they are easy to place at key locations in a structure. The acceleration record can then be computer processed and integrated to obtain the velocity and displacement records.

What does near-real-time versus real-time mean?

A real-time signal is continuously being sent and received from a field instrument to a central site, with little or no delay, much like a newscast or program on TV. Near-real-time is delayed slightly because a communication link is established to send the data once an event occurs, much as one makes a phone call to someone in order to give them a message. Near-real-time communication is more economical than a continuous data link, which makes it attractive for communication of infrequent events like the occurrence of earthquake strong shaking. Real-time communication is thought to be more reliable, but a big earthquake can interrupt many conventional communication pathways. To achieve the most robustness, parallel communication paths can be used for redundancy (which is being done for some stations by CISN).

What is the difference between Richter magnitude and acceleration?

The Richter magnitude indicates the size or strength of an earthquake. For illustration, a parallel can be drawn with how the strength of an explosion will often be reported in terms of tons of TNT (or sticks of dynamite, in old movies). In contrast, the acceleration, or "g force" usually refers to the shaking experienced at a specific point due to the earthquake. This shaking is generally lower at greater distances from an earthquake, just as the sound level experienced from the dynamite blast would be lower at farther away from the explosion.

What do CISN and TriNet stand for?

TriNet was developed after the 1994 Northridge earthquake as a combined effort involving the three networks, Caltech, the US Geological Survey in Pasadena, and the California Strong Motion Instrumentation Program in the California Geological Survey. The TriNet effort was primarily supported by FEMA, through OES. When the funding for that ended for that in late 2000, TriNet transitioned to CISN, the California Integrated Seismic Network, similar to TriNet but adding the two northern California networks, the US Geological Survey in Menlo Park and UC Berkeley. CISN has State support through OES and CGS and federal support though the ANSS effort of the USGS.

Where can I find lists of strong-motion stations in California?

The lists of strong motion stations in California of the CSMIP and NSMP can be found on the web site of each program. In addition, the Northern and Southern California Seismic Networks maintain lists of seismic stations of their networks for both strong and weak motion stations.

Where can I find strong-motion data?

There are several strong-motion data collections for earthquakes of California and elsewhere. These include the Center for Engineering Strong Motion Data, for which the primary data sources are the CSMIP and NSMP strong motion network, with additional strong motion stations of the California and other regions of ANSS. For data immediately after an earthquake, see the CESMD "Internet Quick Report". Additional data collections are the PEER database and COSMOS Virtual Data Center. For earthquakes outside the US, the Virtual Data Center also host datasets for cooperating networks in the world. The CESMD and the Virtual Data Center are in the process of being merged into one-stop data access. Other useful data collections include the European Strong Motion Database, and collection of Japanese earthquake records at Kik-Net.

What types of buildings/structures are instrumented?

The structures that CSMIP and NSMP instrument with earthquake-monitoring devices include buildings, bridges, dams and industrial facilities. CSMIP has instrumented more than 1000 stations which include 700 ground-response stations, 200 buildings, 25 dams and, in cooperation with Caltrans, over 80 bridges. The ANSS/NSMP effort has instruments buildings in Alaska, Seattle and other location, and in cooperation with the Veterans Administration, has instruments in VA hospitals throughout the United State. Sites are selected according to long-term strategies developed in consultation with external advisory committees, such as the Strong Motion Instrumentation Advisory Committee (SMIAC) and the ANSS Building Instrumentation Committee.

What are the products of strong-motion data?

Strong motion data are used for earthquake emergency response, for improving engineering designs, and for research in seismology. For earthquake emergency response, applications such as the ShakeMaps use strong-motion data as input and generate near-real time information on the levels of ground shaking and loss assessment for emergency responders. Structural and earthquake engineers use strong motion recordings to verify or improve design codes. Seismologists used the data in research studies of earthquake fault rupture mechanics, seismic wave propagation and amplitude attenuation with distance.

How do I find out about recent earthquakes?

Maps and lists of recent earthquakes are available for California and the US, produced by the USGS and cooperating networks. The USGS also has a useful site for recent earthquakes, worldwide. Maps of shaking, called ShakeMaps, which show the areas of ground shaking for significant earthquakes, are available for Northern and Southern California, as well as for other regions.