

## Building Instrumentation Facilitates Recovery after an Earthquake

*The firm of Degenkolb Engineers, San Francisco, California, was presented an Honor Award at the ACEC 2005 Engineering Excellence Awards program for their earthquake building instrumentation system.*



*Strategically placed monitors continually relay information on building movement to a central data collection box*

A building owner in San Francisco, CA joined forces with the US Geological Survey (USGS), a supplier, Digitexx Data Systems, Inc., city officials, and Degenkolb Engineers to develop and implement a state-of-the-art, seismic-health monitoring system for a 24-story steel frame building. The team developed an Internet-based, optimized system to continuously monitor building movement and facilitate recovery after an earthquake.

After an earthquake, placards are used to inform the owners, occupants, and the general public about the safety of the building. A building that is posted yellow indicates that occupants are permitted to enter the building to retrieve contents, but not permitted to occupy the building until a structural engineer inspects the structure. Buildings that appear to be so severely damaged that they may collapse in an aftershock are posted red. Occupants are not permitted to enter these buildings for any reason until it is fully evaluated, deemed safe to enter, or sufficiently shored to permit entry and repair.

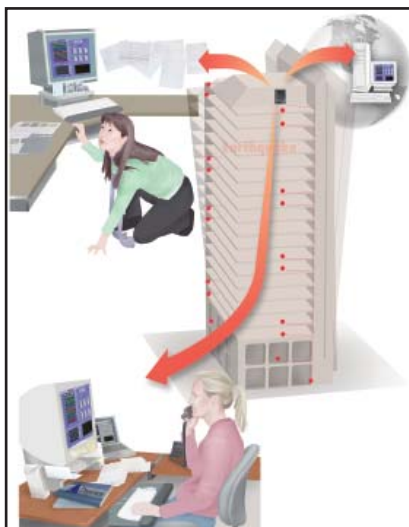
In the hours following a major earthquake, it is very difficult to distinguish when a building should be posted yellow or red. Buildings are frequently posted red and closed — often unnecessarily. Building instrumentation dramatically improves the posting process and

minimizes the amount of time a building is closed during the post-earthquake inspection. Past earthquakes have shown that only about 20% of the red tags posted are really needed. Using this system is likely to result in a yellow tag being posted 60% of the time and a green tag 20% of the time instead of a red tag.

Building instrumentation specifically designed and installed for post-earthquake inspection and recovery is a groundbreaking first step in developing a strategy that can protect communities from economic and human devastation after a major earthquake. This high-performance, low-cost, real-time instrumentation system has several critical benefits:

- Provides an immediate opinion about the need to evacuate the building
- Delivers important data to key users permitting informed decision-making
- Provides critical building performance information needed by structural engineers to return the facility to operation
- Allows the rapid identification of areas within the building where hidden structural damage has likely occurred
- Enhances engineers' knowledge of the structure through ongoing monitoring of the building movements.

The monitoring system, when coupled with the post-earthquake inspection process, greatly improves the likelihood that the assigned inspecting engineers will be able to immediately post the building as safe to occupy (green placard), than would otherwise be the case.



*In the event of an earthquake, a predetermined structural engineer monitors incoming data to assess the building*



*The monitoring system greatly improves the likelihood that the assigned inspecting engineers will be able to immediately determine if the building is safe to occupy*

Specific time records of the building's movements during an earthquake add credibility to a decision to allow a building to remain occupied.

Degenkolb worked with the building owner and the team to meet two important objectives:

- The rapid assessment of building integrity following an earthquake
- Quick delivery of data so that informed decisions about occupancy can be made.

Working with Digitexx Data Systems, the instrumentation and software, the team developed a PC-based monitoring system with a server at the building site. Remote users can access the information from any point in the world with Internet access. Degenkolb evaluated the building and determined the appropriate engineering parameters of interest and thresholds for posting (e.g. drift ratios).

The system developed for this project can also be used effectively for structural performance monitoring of buildings, bridges, dams, and other structures for natural and man-made extreme events. An Internet-based interface can be easily adapted for e-mail notification to emergency response agencies and other decision makers.

As a result of building instrumentation, critical facilities and institutions can return to operation more swiftly and the economic toll of closed businesses and lost buildings mitigated.■