Watching over the water system: Engineers design sensors to monitor pipes after earthquakes

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After a big earthquake, it's key to keep the water system afloat. Water is necessary for life, and it fights the fires that often accompany such disasters.

UC Irvine engineers plan to outfit the local water system with sensors that will alert officials when and where pipes crack or break, hastening repair - thanks to nearly $5.7 million over three years from the National Institute of Standards and Technology and several local water groups.

"When an earthquake occurs and infrastructure systems fail, continued service of the water network is most critical," said Masanobu Shinozuka, lead project investigator and civil & environmental engineering chair. "Before anything happens, I'd like to have a pipe monitoring system in place to let us know when and where damage occurs. It could minimize misery and save lives."

About 240,000 water-main breaks occur per year in the U.S., according to the Environmental Protection Agency. For example, in December a burst sent about 150,000 gallons of water per minute onto a busy Maryland road, stranding motorists in the icy deluge. Water system failures are estimated to waste up to 6 billion gallons of drinking water every day.

Shinozuka and Pai Chou, electrical engineering & computer science

associate professor, have created CD-sized sensing devices that attach to the surface of pressurized (drinking water) and nonpressurized (wastewater) pipes. They will detect vibration and sound changes that could indicate pipe problems. Through antennae, the sensors will relay information wirelessly over long distances to a central location for recording, processing and diagnostic analysis.

Initially, the sensor network will cover about one square mile of the local water system; eventually, it could encompass more than 10 square miles - the largest of its kind to date. A small-scale pressurized water pipe network designed and built by UCI researchers has confirmed that this type of damage identification works well.

The research team now is designing a system that functions underground as well as over a larger area. The main hurdles, Shinozuka said, are powering the sensors (batteries and solar energy are not strong enough), making them more cost-effective and robust in tough environments, and achieving long-range wireless communication efficiently and accurately.

Using existing pipe networks, the team will then test and calibrate the sensors by simulating and monitoring pressure changes equivalent to those arising from actual pipe damage. The sensors will complement an existing monitoring system called Supervisory Control and Data Acquisition.

"SCADA sensors are too sparsely placed for identifying damage with the kind of precision we desire when a large earthquake or other natural hazard affects many locations," Shinozuka said.

"An isolated malfunction is far different from a situation in which pipes break all over the place," he said. "Our next-generation system will inform us as soon as possible when and where damage occurs and to what extent so we can better mitigate the consequences."

As the research progresses, the team plans to develop methods of rapidly repairing pipe damage at joints and other vulnerable locations.

Source: University of California - Irvine