More fully-implemented Structural Health Monitoring can aid in resilience of communities after disasters

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The Los Angeles Times in the USA reported that 250’000 - 400’000 people could be displaced following a hypothetical catastrophic earthquake in California[1]. After surviving such an ordeal, the next line of thinking is how to deal with the aftermath.

Communities around the globe are working to improve their resilience in the face of disasters, with initiatives such as the USGS’s HayWired Scenario[2] – a hypothetical depiction of what would happen if a 7M earthquake hit the SF Bay Area; ShakeOut[3] – a global initiative that encourages preparing for earthquakes with drills; and Resolve to be Ready[4] – a U.S. campaign promoting simple steps in order to be ready in an emergency. The EU is funding or has funded research projects on “History lessons for a more resilient future[5],” “Culture and risk management in man-made and natural disasters (CARISMAND)[6],” “ResiStand – Increasing disaster resilience by establishing a sustainable process to support standardisation of technologies and services[7],” and “RECONASS – Reconstruction and Recovery Planning: Rapid and Continuously Updated Construction Damage, and Related Needs Assessment[8]” to name but a few. We understand the potential dangers, and we understand that preparation is needed.

Swiss manufacturer GeoSIG, which provides solutions for vibration and earthquake monitoring, has noticed a gradual increase in awareness about structural health monitoring (SHM). Johannes Grob, Managing Director of GeoSIG, believes that the technology has become more sophisticated over the years while the prices have been reduced. This has meant that SHM solutions are more accessible and are much more widely used. GeoSIG was one of the consortium members of RECONASS, an EU-funded project. This was a highly comprehensive solution which brought many different technologies together for an ultimate turnkey solution for monitoring buildings against not only natural disasters but man-made disasters and terrorist attacks.

SHM can be instrumental in improving the resilience of communities after an earthquake disaster by 1) showing the impact of such disaster on the structural health of buildings, 2) providing data that allows building owners or officials to determine whether it is safe to return to the building (a.k.a. occupancy resumption) after the disaster (sooner than if waiting for conventional building inspections), 3) providing data that allows building owners or officials to determine necessary repairs and their cost, 4) providing data that allows for early repairs, which may allow homeowners to return to their homes sooner or businesses to return to their work sooner, and 5) providing better insurance coverage and premium rates for monitored structures, thereby improving efficiency and feasibility of insurance services.

According to FEMA, the four primary phases of disaster/emergency planning are: 1) Preparedness, 2) Response, 3) Recovery and 4) Mitigation. With SHM, building owners are making preparations ahead of a disaster. The feedback received during and following a disaster allows for appropriate response and recovery, and mitigates risk. SHM can be a key part of disaster planning.

In cases of civil infrastructure, SHM can provide essential information in times of disaster when utilized in vital areas. SHM could allow hospitals to determine whether it is safe to continue to operate during or following a disaster, which would reduce waiting times for patients and might save lives. It would inform operators at power plants of structural damage that could mean fixing a problem sooner and restoring power supplies sooner. It could reassure authorities that bridges were safe for crossing in an evacuation, or that a stadium were safe to shelter displaced people. By receiving accurate, up-to-the-minute information following a disaster, people can make informed decisions that affect a wider audience.

But SHM could be an asset to homeowners, apartment building owners or business owners as well, which would improve community resilience. According to The HayWired Scenario[2], analyses suggest a 7M earthquake in the East Bay area would result in more than $82 billion in property and direct business interruption losses just from the shaking alone, with water service disrupted for 6 weeks for the average person and up to 6 months for some.

In the first days and weeks following an earthquake, for example, some people will have returned home and to work, but others may have evacuated and still be displaced. SHM could help determine whether a structure is unsafe and should not be occupied. It could help determine the location and extent of damage, and even the estimated cost of repair. Building inspectors will be very busy following a large disaster, but SHM could lessen the waiting time. Letting evacuated people know that it is safe to return home means less of a strain on resources at shelters and fewer people displaced for a shorter time period. It could let schools and businesses reopen sooner, which could help the community get back to life as usual.

While there is much that goes into disaster planning -- from emergency management and evacuations, to interruption and restoration of utilities, from setting up emergency shelters and getting them supplied, to disease control and sanitation – SHM could be another way individuals and agencies could prepare for disaster and be more resilient in the aftermath. Once they are safe, they are more able to turn around and help their neighbours and community.

In promoting awareness about SHM even amongst technically-minded individuals, Dr Talhan Biro, Sales Director at GeoSIG, has developed the SHM software GeoSMART and created a portable miniaturised wireframe building model equipped with accelerometers connected to their Multichannel Digitiser/Recorder CR-6plus, which has received highly positive feedback when shown at different events. The demonstration model is excited by a motorised shake table to demonstrate the vibration/earthquake, and the response of the wireframe model then displays on a computer screen, captured on GeoSMART, providing near realtime data acquisition, performance parameters' calculation and visual output for several major criteria such as acceleration, displacement, inter-storey drift, torsional motions, frequencies as well as exceedance of any measured and/or calculated parameter. The system also provides configurable alarms for notification purposes.

Dr Reza Ghadim, the Marketing Director at GeoSIG, commented that they are now receiving considerably more enquiries and a very high profile construction company is considering to implement SHM in many of their high value buildings, including regions where seismicity is not an issue, but other natural and manmade events may be a concern regarding structural health — to improve the sustainability of their precious investments.

It is common sense to see SHM growth over the coming years, especially because the awareness is rapidly growing on the relative minor initial cost of deploying SHM systems when compared to structure's value, which is a well returned investment in terms of the significant savings plus the invaluable benefits in terms of safety as well as peace of mind during and after a disaster.

Having the necessary solutions and more importantly experience and reference installations, GeoSIG is determined to continue developing more cost effective and easily deployable turnkey SHM solutions.

Sources:

1. Lin, Ron., 2018, “When the Big One hits, it could leave 250,000-400,000 quake refugees in California. Where will they go?” *The Los Angeles Times*. June 4.
2. Detweiler, S.T., and Wein, A.M., eds., 2018, The HayWired earthquake scenario—Engineering implications: U.S. Geological Survey Scientific Investigations Report 2017–5013–I–Q, 429 p., https://doi.org/10.3133/sir20175013v2.
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