nehrp SeismicWaves
How the National Earthquake Hazards Reduction Program Is Advancing Earthquake Safety
September 2011

ROVER: New End-to-End Software for Managing Seismic Risk

The Federal Emergency Management Agency (FEMA) has teamed with the Applied Technology Council (ATC) and private-sector partners to create a new tool to screen and evaluate buildings for seismic risk. Now available online and on CD-ROM, the Rapid Observation of Vulnerability and Estimation of Risk (ROVER) software automates two international standard paper-based methodologies: FEMA P-154, *Rapid Visual Screening (RVS) of Buildings for Potential Seismic Hazards*, and ATC-20, *Postearthquake Safety Evaluation of Buildings*.

Why ROVER?

ROVER will help to address emerging and ongoing challenges at the national and community levels. From the national perspective, the majority of today's building stock was not designed to withstand earthquake effects. In recent testimony before Congress, Chris Poland, Chair of the National Earthquake Hazards Reduction Program (NEHRP) Advisory Committee on Earthquake Hazards Reduction (ACEHR), discussed the focus on the built environment. "As the result of the damage and economic impact that occurred during major earthquakes and other natural disasters over the past 20 years, the primary goal of hazard reduction has shifted from one aimed at protecting people to one that also seeks to protect the built environment to the extent necessary to allow rapid recovery…This change in performance expectation is often referred to as a change from a life safety goal to a resilience goal. Achieving this goal is the focus of the current strategic plan for the NEHRP."[1]

At the community level, cities and owners of building portfolios prepared to mitigate seismic risk face challenges in assembling building inventory data. They first need to document the existing condition of buildings before an earthquake to establish a baseline. Relevant data include building locations, site soil, and key seismic building features. These data can be used to identify buildings that may be at high risk for serious damage or even collapse. Owners can then assess and prioritize risk-mitigation efforts and develop post-earthquake assessment plans. Immediately after an earthquake, a screening can be quickly carried out to identify buildings most likely to be damaged; this information can be used to prioritize actual inspections. While trained inspectors can perform most building damage assessments, owners may need to have structural engineers conduct detailed safety inspections on seriously damaged structures. Preliminary repair-cost estimates also may be needed. All of these steps take time and resources.

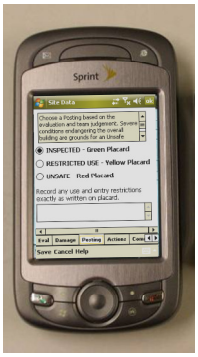
Streamlining Data Collection and Analysis

ROVER combines the attributes of ATC-20 and FEMA 154 with the advantages of automation. The FEMA 154 methodology, which has been successfully implemented in communities nationwide since 1988, uses efficient, standardized, and well-established procedures to assess and manage the seismic safety of a building stock. With the automation now provided by ROVER, inspectors no longer need to juggle papers, clipboard, and camera, and managers no longer need to transcribe paper forms.

Before an earthquake, a trained inspector takes a smartphone equipped with ROVER into the field and collects and stores building data, including building location, use, number of occupants, number of stories, site soil classification and seismic hazard level, sketches, photographs, and other features (geolocation is captured via a Bluetooth GPS device). The data are then uploaded to a secure Internet-accessible server. Once the data reach the server, ROVER automatically looks up site-specific soil conditions and seismic hazard from onboard copies of national soil and seismic hazard maps that are integrated into the server software. Users can export ROVER data to Google Earth, which helps elected officials and others who use maps for decision-making and communicating with the public. For future reference, the server also watermarks photos with identifiers, such as building name, date and time of inspection, and latitude and longitude.

Left: Building vulnerability data are collected in the field with ROVER on a smartphone.

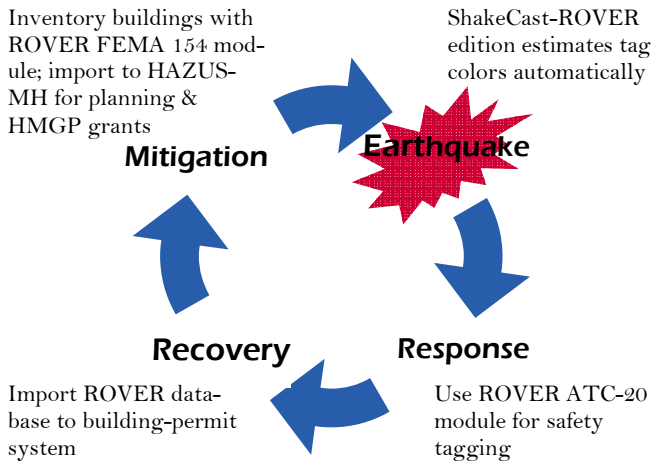
Right: ROVER is used for safety tagging by inspectors after an earthquake.



[1] Chris Poland, Testimony on behalf of the American Society of Civil Engineers before the Technology and Innovation Subcommittee, House Science, Space and Technology Committee, April 7, 2011.

In the event of an earthquake, ROVER has an inspection module that encodes the ATC-20 methodology. Using this methodology, an inspector posts the building with a red ("unsafe"), green ("inspected"), or yellow ("restricted use") placard. Data on the smartphone are uploaded to the server, allowing colleagues to examine the data remotely in real time and provide advice without personally travelling to the site. Safety decisions can thus be made more rapidly and inexpensively and by a larger volunteer workforce (most ATC-20 inspections in large events are made by trained volunteer professionals, many of whom travel from outside affected areas).

ROVER shares data with two other tools to manage seismic risk: HAZUS-MH, developed for FEMA by the National Institute of Building Sciences, and ShakeCast, software from the U.S. Geological Survey (USGS). HAZUS-MH estimates repair costs, casualties, and loss-of-use duration for historic or hypothetical future earthquakes, including buildings' future economic and life-safety risk. ShakeCast monitors the occurrence of earthquakes that could affect buildings of interest. Once an earthquake occurs, ShakeCast automatically displays a map of the shaking (a "ShakeMap"), shows where the buildings are and how strongly they were shaken, and estimates those buildings most likely to be considered unsafe. The figure below shows how the tools work together in each stage of the earthquake disaster, response, recovery, and mitigation cycle.



ROVER Pilot Tests in Utah and Los Angeles

In a 2009 simulation of a magnitude 7 earthquake on the Salt Lake City segment of the Wasatch Fault, HAZUS-MH estimated fatalities of 2,300 to 2,900 and $35.4 billion in losses to buildings alone. Similar to other states, many schools in Utah were built before the implementation of modern seismic codes using unreinforced masonry and other construction practices not allowed by today's codes. Concerned with the risk, the Utah Seismic Safety Commission (USSC) and the Structural Engineers Association of Utah (SEAU) formed a joint committee and organized a pilot project to screen a sampling of schools along the Wasatch Fault. In September 2010, 17 volunteer engineers trained by ATC in the use of ROVER conducted the survey of the earthquake safety of 128 school buildings. Sixty percent of the buildings scored 2.0 or lower, implying a 1-in-100 or greater chance of life-threatening damage during the maximum considered earthquake, and indicating the need for detailed seismic evaluation and possibly seismic mitigation of those buildings.[2] After the project, USSC and SEAU proposed to the Utah legislature a bill to create a Utah School Seismic Hazard Inventory and recommended conducting the rapid visual screening of all Utah schools. In 2008, ROVER also was successfully tested by the Los Angeles Unified School District as part of the School District's participation in the Great Southern California ShakeOut.

Web Client

The ROVER Server can now operate as an online service for the ROVER smartphone client and as a web site for direct access by any web browser. The web site service also has been optimized for the small screens found on a smartphone or on any Internet-connected tablet.

ROVER was developed for FEMA by ATC, SPA Risk LLC, and Instrumental Software Technologies, Inc. The ROVER Development Partners will support and enhance ROVER and maintain a user-support web page. FEMA will continue to play an important role in implementation and outreach to NEHRP customers.

To download the free software, visit www.atc-rover.org, or order the ROVER CD-ROM (FEMA P-154 ROVER CD) from the FEMA Publications Warehouse.

[2] Lee J. Siegel, *Utah Students at Risk: The Earthquake Hazards of School Buildings, A Preliminary Survey by the USSC and the SEAU*, February 2011.