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Final Technical Report

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Abstract

The Ridgecrest Earthquake Sequence included the largest earthquake in California in 20 years. It presented a major learning opportunity for the U.S. earthquake risk reduction community and led to many research activities. The earthquake seismology community investigated the source of the earthquakes. The strong motion community focused on the deployments of instruments that captured aftershocks in the sequence. Geologists thoroughly measured the surface manifestations of the earthquake, including surface rupture and other types of ground failure. Geodesists used ground based and satellite measurements to capture near- and far-field deformation. Geotechnical engineers examined the relationship between the ground motions, ground failure, and the causes of damage to building foundations and other infrastructure. Structural engineers studied the relationship between ground motions, modern building codes, and the impacts to the built environment. Lifelines investigators documented impacts of ground deformation on infrastructure systems.

In partnership with the USGS and NSF, the Earthquake Engineering Research Institute (EERI) organized Ridgecrest Earthquake Sequence One-Year Anniversary programming at the 2020 National Earthquake Conference. This programming provided the critical opportunity to connect researchers and practitioners to ensure that the findings and observations from research are translated into practice to reduce the earthquake risk in California and the nation. Gathering contributors together in one venue also provided an opportunity to bring the earthquake risk reduction community (academia, private researchers, practitioners, and government agencies) together to understand the full breadth of the data and observations, in order to pursue future research and mitigation implementation accordingly.

The programming included one plenary session, two breakout sessions, and a poster session. The National Earthquake conference was attended by nearly 600 participants from across the nation. The Ridgecrest Earthquake Sequence sessions covered a wide range of topics including seismology, geology, ground motions, structural and geotechnical engineering, lifelines, and emergency management and response. They provided a venue for post-earthquake investigators and the broader earthquake risk reduction community to gather and present a very wide range of observations. During the sessions, participants engaged in stimulating, cross-disciplinary discussions about future research needs.

Introduction

About EERI

Founded in 1948, EERI is a non-profit membership organization that connects more than 2,500 multidisciplinary professionals dedicated to reducing earthquake risk. Our mission is to 1) advance the science and practice of earthquake engineering, 2) improve the understanding of the impact of earthquakes on the physical, social, economic, political, and cultural environment, and 3) advocate for comprehensive and realistic measures for reducing the harmful effects of earthquakes. EERI's multidisciplinary membership — including engineers, geoscientists, social scientists, architects, planners, emergency managers, academics, students, and other like-minded professionals — advances our mission through volunteer committees, projects, and chapters.

EERI Role in Post-Earthquake Technical Clearinghouses

The Plan to Coordinate NEHRP Post-Earthquake Investigations (Circular 1242), published by USGS in coordination with FEMA, NSF and NIST, "presents the plan to coordinate domestic and foreign post-earthquake investigations supported by the National Earthquakes Hazards Program (NEHRP)." All four NEHRP agencies have a role in the plan, along with other federal programs, state agencies and select non-governmental organizations, most notably EERI.
In Phase I, immediately to several days following a significant domestic earthquake, EERI has the principal responsibility for establishing a technical clearinghouse website that among other features will collate and link to engineering information as provided by agencies, research institutions and private practice. EERI is also expected to coordinate with FEMA and USGS in working with state agencies to organize a physical field technical clearinghouse. The physical clearinghouse serves a vital role as the focal point for coordinating reconnaissance activities and promoting safe field practices during initial post-earthquake investigations.

EERI serves as vice-chair of the California Earthquake Clearinghouse which has been in continuous operation in some form since 1972. Since the Northridge earthquake there has been a more coordinated effort to include all organizations having responsibilities in post-earthquake investigations, including representatives from the USGS. Multiple agencies have played major roles in the formation and activation of the Clearinghouse over the past thirty years. In EERI's role as Vice-Chair staff are responsible for operating clearinghouse locations in California and coordinating field investigators who check-in at the clearinghouse.

Ridgecrest Earthquake Sequence Clearinghouse Activation

Within the first few hours after the July 4th, M6.4 Ridgecrest earthquake, consideration to activate the California Earthquake Clearinghouse was strongly influenced by the magnitude of the earthquake and incoming reports of fault rupture, fires, and damage. By 5:00 pm, announcements went out that the clearinghouse would activate and representatives from CGS, USGS, and Cal OES at the State Operations Center were working with state level partners to establish a physical location in Ridgecrest. On the morning of July 5, the Kerr McGee Center, 100 West California Avenue, Ridgecrest, California was identified as available. The first evening

briefing was scheduled for 8:00 pm that evening. It was during that briefing that the M7.1 earthquake occurred, leading to a temporary evacuation of the clearinghouse location. The physical Clearinghouse was operational from Friday afternoon, July 5th until Friday morning, July 12th. There were a total of nine evening briefings with six held in Ridgecrest from July 5 – July 11 and after the Clearinghouse location closed, three more virtual clearinghouse briefings were conducted on July 15, 22, and August 12.

During its seven days of operation, over 60 experts from 20 organizations visited the clearinghouse location and participated in reconnaissance activities and another 100 people participated in the evening briefings remotely. Their expertise spanned many disciplines: geosciences, geotechnical engineering, structural engineering, nonstructural components, insurance, lifelines, transportation, government, risk analysis, and business continuity.

Ridgecrest Earthquake Sequence One-Year Anniversary Event

Programming

As outlined in USGS Circular 1242, EERI partnered with the NEHRP Investigations Coordinator, Kate Scharer, USGS, to organize a one-year later event to capture the lessons learned from the breadth of preliminary post-earthquake investigations and bring together the over 160 people that participated in the clearinghouse activation for the earthquake sequence. The one-year later event was incorporated into the 2020 National Earthquake Conference (NEC) that had already been scheduled for March 2020. As part of the conference, several one-year anniversary sessions were included in the NEC program. The sessions included one plenary session, two breakout sessions, and a poster session.

The two breakout sessions summarized the major findings, lessons learned, and future research directions in earth science and engineering. The first session, titled “Science Findings and Lessons,” was moderated by Christine Goulet, SCEC, and included the following topics and speakers:

- Geodesy and InSAR by Eric Fielding, NASA
- Seismology, Annemarie Baltay, USGS
- Fault Rupture, Tim Dawson, California Geological Survey
- Aftershock Forecasting, Kevin Milner, Southern California Earthquake Center
- Ground Motions, Silvia Mazzoni, UCLA

The second session, titled “Engineering Findings and Lessons,” was moderated by Janiele Maffei, CEA, and included the following topics and speakers:

- EERI Ridgecrest Response by Maggie Ortiz-Millan, EERI
- Geotechnical Impacts by Jonathan Stewart, UCLA/GEER
- Structural Impacts at the Naval Air Weapons Station China Lake by Dave Swanson, Reid Middleton
- Impacts to Manufactured Housing by Kelly Cobeen, Wiss, Janney, Elstner Associates

- Structural Impacts to Housing and Commercial Buildings, Wayne Chang, Structural Focus
- Lifelines Impacts, Craig Davis, LA Department of Water and Power (retired)

The NEC poster session included 27 Ridgecrest-focused posters. Poster presenters all had the opportunity to make a short 1-minute lightning presentation to briefly describe their research and give a preview of what could be learned from their poster. The poster session provided an opportunity for more participants to share their post-earthquake research.

On the final day of the conference, a plenary session titled “Local Perspectives from the Ridgecrest Earthquake Sequence” was included in the program. Moderated by Kate Scharer, USGS, this session provided an opportunity to hear from local officials about the response and recovery from the Ridgecrest Earthquake Sequence. Speakers included:

- Jed McLaughlin, Ridgecrest Chief of Police
- Sean Frieberg, U.S. Navy
- Robyn Moses, Red Cross

In addition to the designated one-year programming, the National Earthquake Conference also included 5 other presentations related to the Ridgecrest Earthquake Sequence. These presentations were:

- 2019 Ridgecrest Earthquake Sequence Clearinghouse Lessons Learned and Opportunities, Cindy Pridmore, CA Geological Survey
- Responding to the Ridgecrest Earthquake Sequence, Jed McLaughlin Chief of Police, Ridgecrest
- Ridgecrest Regional Hospital Post-Earthquake Assessment after the 2019 M6.4 and M7.1 Earthquakes, Daniel Zepeda, Degenkolb Engineers
- Failure to alert? Exploring Perceptions of ShakeAlert During the 2019 Ridgecrest Earthquake Sequence, Sara McBride, USGS
- New National Aftershock Forecast Capabilities and Application to the Anchorage And Ridgecrest Earthquakes, Jeanne Hardebeck, USGS

Nearly 600 people attended the National Earthquake Conference, with hundreds attending at least one of the Ridgecrest Earthquake Sequence 1-year anniversary sessions. With support from the USGS, 10 attendees received full or partial participant support. Participant support recipients include:

- Sean Freiberg, U.S. Navy
- Jed McLaughlin, Ridgecrest Chief of Police
- Silvia Mazzoni, UCLA
- Craig Davis, LA Department of Water and Power (retired)
- Robyn Moses, Red Cross
- Kevin Milner, University of Southern California
- Zoe Yin, UC San Diego

- Rachel Adams, Natural Hazards Center, University of Colorado Boulder
- Sean Ahdi, UCLA
- Wael Hassan, University of Alaska, Anchorage

Project Data

No scientific data was collected or produced through this grant. However, presentations from the one-year anniversary sessions are available on the Ridgecrest Earthquake Sequence Virtual Earthquake Clearinghouse Website.

Bibliography

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