

ATC 20-1 Bhutan

**Field manual:
postearthquake safety
evaluation of buildings**



Applied Technology Council



Royal Government of Bhutan

**ATC-20-1 Bhutan
Field Manual: Postearthquake Safety
Evaluation of Buildings**

Prepared for
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by
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Applied Technology Council

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GeoHazards International

GeoHazards International (GHI) is a nonprofit organization with offices in the United States, Bhutan, and India that works to reduce loss of life and suffering in global communities that are most at risk from earthquakes, tsunamis, landslides, storms and floods. GHI's approach emphasizes preparedness, mitigation and advocacy. GHI serves the most vulnerable communities, meaning people who face very high risk and have very low capacity to manage it. The combination of urban growth, poor construction quality, and poor urban planning greatly increases vulnerability to natural hazards. To help mitigate these risks, GHI draws from practices used successfully in the United States, Japan, and New Zealand and brings together experts in science, engineering and policy to mentor local professionals. Building local capacity this way ensures that safe and affordable practices take hold. The aim is to help communities avoid crippling development losses so they can continue their economic, political and cultural development unimpeded by natural disasters. GHI has been working toward global hazards safety since 1991 while remaining independent of political, business or research pressures.

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Preface

In 2009, the magnitude-6.1 Mongar earthquake in the east of Bhutan caused significant losses considering the small population and limited economy of Bhutan, killing 12 persons and damaging 446 homes, 36 temples, six schools, and two basic health units beyond repair. A Post-Disaster Needs Assessment (PDNA) conducted by the United Nations Development Programme (UNDP) following the earthquake estimated \$52 million in direct losses (RGoB, 2009). These losses provided motivation for the development of a damage assessment methodology specific to Bhutan. The resulting methodology was implemented following the 2011 earthquake that occurred 100 kilometers west of the Bhutan border in Sikkim (India), but the assessment did not consider safety of occupants.

In 2012, in order to meet the need for safety assessments, GeoHazards International (GHI), the Applied Technology Council (ATC), and the Royal Government of Bhutan's Department of Engineering Services (DES) and Department of Disaster Management (DDM) formed a unique partnership with support from the World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR) and the Applied Technology Council Endowment Fund, in order to develop postearthquake safety evaluation guidance specific to Bhutan.

This document is an adaptation of the ATC-20 methodology, *Procedures for Postearthquake Safety Evaluation of Building*, used world-wide. The Applied Technology Council first published the ATC-20 report in 1989 to document procedures and guidelines for the safety evaluation of damaged buildings. The document was written specifically for use by volunteer structural engineers, and for building inspectors and structural engineers from city building departments and other regulatory agencies, who would be required to make on-the-spot evaluations and decisions regarding continued use and occupancy of damaged buildings. Two weeks after the completion of the ATC-20 report, the magnitude-6.9 Loma Prieta earthquake struck the San Francisco Bay Area in California and caused casualties and significant damage to buildings and infrastructure. Immediately following the earthquake, the ATC-20 methodology was used. Since 1989, a family of ATC-20 documents has been developed; the most current document was published in the United States in 2005, and is the second edition of a field manual (ATC-20-1) providing the ATC-20 methodology in a concise, easy-to-use field reference document that trained professionals can take into damaged areas. This ATC-20-1 Bhutan *Field Manual* provides Bhutanese engineers with a similar field reference.

This document represents adaptations to the U.S. version of the ATC-20-1 *Field Manual* to account for Bhutan's vernacular buildings, as well as Bhutan's cultural and governmental context. During the development, a number of improvements were made to the presentation of material in the ATC-20-1 *Field Manual*, including a graphical format with numerous images to help engineers evaluate damaged buildings more accurately. Also, the procedures incorporate recent lessons learned during postearthquake safety evaluations following the Chile (2010) and New Zealand (2010-2011) earthquakes.

This document was developed under the leadership of authors Bret Lizundia and Janise Rodgers. A bilateral U.S.-Bhutan Project Engineering Panel, consisting of Jampel Dorji, Nagtsho Dorji, Melvyn Green, William Holmes, Yeshey Lotay, Karma Namgyel, Sonam Norbu, Pema, Thomas Tobin, and Sonam Yangdhen, guided the development efforts. Karma Doma

Tshering of GHI coordinated interactions between DES, DDM, ATC, and many local stakeholders in Bhutan. Sonam Yangdhen and Yeshey Lotay served as the project focal points for DES and DDM, respectively. Ayse Hortacsu managed the project for ATC and Amber Houchen provided report production services. Additional engineers from a number of government agencies provided input during a project workshop held in Thimpu. The names and affiliations of all who contributed to this report are provided in the list of Project Participants. All photos and illustrations in this document were submitted by the Project Participants, unless otherwise noted.

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