

ATC-38

Database on the Performance of Structures Near Strong-Motion Recordings: 1994 Northridge, California, Earthquake

by

APPLIED TECHNOLOGY COUNCIL
201 Redwood Shores Parkway, Suite 240
Redwood City, California 94065
www.atcouncil.org

Funded by

U. S. GEOLOGICAL SURVEY
SOUTHERN CALIFORNIA EARTHQUAKE CENTER
CALIFORNIA OFFICE OF EMERGENCY SERVICES
INSTITUTE FOR BUSINESS AND HOME SAFETY

PRINCIPAL INVESTIGATOR

Christopher Rojahn

CO-PRINCIPAL INVESTIGATORS

Chris D. Poland
Charles Scawthorn

TECHNICAL CONSULTANTS

Robert A. Bruce (Survey Design)
Stephanie A. King (Database and Report Development)

SURVEYORS

Steven K. Harris, Lead	S.S. Ivanovic
Evan Reis, Lead	Tom Kamei
Michael Baltay	Donald R. Kay
Hong Cao	Roy Lobo
Michael Cochran	Rob Onishi
Rami Elhassan	Raymond S. Pugliesi
Martin Graves	Jeff Soulages
Adam Greco	Herbert Stockinger
Jon Heintz	Maria Todorovska
James A. Hill	Brian Unsderfer
Saad Ibrahim	George Zorapapel

2000

Preface

In the weeks and months following the damaging 1994 Northridge, California, earthquake, the Applied Technology Council (ATC) was awarded a series of contracts to document systematically the characteristics and performance of buildings in the vicinity of sites where strong ground-motion data had been recorded. Initial funding was provided by the U. S. Geological Survey (USGS) through the ongoing ATC-35 project, and subsequent supplemental funding was provided by the Southern California Earthquake Center, the California Office of Emergency Services (through an existing contract with EQE International), and the Institute for Business and Home Safety.

The project design called for (1) development of a standardized survey form to document the characteristics and performance of buildings affected by strong ground shaking; (2) training of licensed structural and civil engineers to conduct the surveys; (3) selection of areas to be surveyed near strong-motion recording sites; (4) surveying of buildings near the selected strong-motion recording sites; (5) design and development of a database containing the survey data; and (6) development and publication of a report documenting the project approach and results.

The ATC project team surveyed 530 buildings located in the vicinity (i.e., within 1000 feet) of 31 strong-motion recording stations in the Los Angeles area. The data, survey procedures, and preliminary analysis of the data are described in this report. The report also contains results from a separate survey to obtain data on repair costs and the loss of function of commercial buildings.

The data from both surveys are provided in their entirety on a CD-ROM accompanying this report.

The Applied Technology Council gratefully acknowledges the wide range of personnel involved in developing the ATC-38 data and report. The project concept was developed by Christopher Rojahn (Principal Investigator), Chris D. Poland and Charles Scawthorn (Co-Principal Investigators), in consultation with Al Lindh and Mehmet Celebi of the USGS. Robert A. Bruce designed the survey form, and Steven K. Harris and Evan Reis served as lead surveyors and trainers of other survey personnel: Michael Baltay, Hong Cao, Michael Cochran, Rami Elhassan, Martin Graves, Adam Greco, Jon Heintz, James A. Hill, Saad Ibrahim, S. S. Ivanovic, Tom Kamei, Donald R. Kay, Roy Lobo, Rob Onishi, Raymond S. Pugliesi, Jeff Soulages, Herbert Stockinger, Maria Todorovska, Brian Unsderfer, and George Zorappal. Stephanie A. King designed and developed the survey database, and prepared this report. ATC staff entered and verified the data. Ronald T. Eguchi and Stephanie Chang carried out a separately funded survey of commercial establishments to obtain data on repair costs and loss of function and graciously turned the data over to ATC for inclusion with this report. The affiliations of these individuals are provided in the list of Project Participants.

Christopher Rojahn
ATC Executive Director

Contents

Preface.....	iii
Contents	v
List of Figures.....	vii
List of Tables	xvii
1. Introduction.....	1
1.1 Background.....	1
1.2 Purpose and Scope.....	1
1.3 Organization of Report	2
2. Data Collection	5
2.1 Building Survey Information	5
2.1.1 Data Collection Forms	6
2.1.2 Selection of Recording Sites.....	8
2.1.3 Survey Procedures	8
2.2 Strong-Motion Recordings	8
3. Database Development	27
3.1 Overview of ATC-38 Database	27
3.2 Building Survey Information	27
3.2.1 Data Entry	27
3.2.2 Data Standardization, Verification, and Correction.....	27
3.2.3 Database Table Structure	31
3.3 Strong-Motion Recordings	31
3.3.1 Data Entry	31
3.3.2 Database Table Structure	37
4. Data Summary and Preliminary Analysis.....	43
4.1 Summary of Building Survey Data.....	43
4.2 Summary of Strong Motion Data.....	43
4.3 Preliminary Data Analysis	48
4.4 Follow-up Study on Repair Cost and Loss of Use.....	54
5. Conclusions and Recommendations	61
5.1 Summary	61
5.2 Future Work.....	61
5.3 Revised Survey Form.....	61
Appendix A: Plots, Maps, Representative Photographs, and Data for Recording Stations	73
Appendix B: Northridge Earthquake Building Repair Survey	229
B.1 Background.....	229
B.2 Questionnaire Design.....	229
References.....	239

Project Participants.....	241
Applied Technology Council Projects and Report Information.....	243
Applied Technology Council Directors.....	259