Proceedings of
ATC-35 Seminar on New Developments in Earthquake Ground Motion Estimation and Implications for Engineering Design Practice

Los Angeles, California
January 26, 1994

San Francisco, California
January 27, 1994

Seattle, Washington
February 2, 1994

New York, New York
February 9, 1994

Memphis, Tennessee
February 10, 1994

by
APPLIED TECHNOLOGY COUNCIL
555 Twin Dolphin Drive, Suite 550
Redwood City, California 94065

Funded by
U. S. GEOLOGICAL SURVEY
Reston Virginia

PROJECT MANAGEMENT
Christopher Rojahn, Principal Investigator (PI)
Maurice Power, Project Director and Co-PI
Charles C. Thiel, Jr., Co-PI
Chris D. Poland, Consultant

STEERING COMMITTEE
Arthur D. Frankel
Thomas H. Heaton
Thomas L. Holzer
I. M. Idriss
Klaus H. Jacob
William B. Joyner
Helmut Krawinkler
Bijan Mohraz*
Allan R. Porush
Paul G. Somerville
Randall G. Updike
Nabih Youssef

*ATC Board Representative
In January and February 1994, the Applied Technology Council (ATC) conducted a series of five regional seminars on "New Developments in Earthquake Ground Motion Estimation and Implications for Engineering Design Practice." The seminar series served as the initial activity in a larger U. S. Geological Survey-sponsored project to "Transfer U. S. Geological Survey Research Results into Engineering Design Practice" (ATC-35 Project).

The five initial seminars, designed for practicing structural and geotechnical engineers, were conducted in Los Angeles, California (January 26, 1994), San Francisco, California (January 27, 1994), Seattle, Washington (February 2, 1994), New York, New York (February 9, 1994), and Memphis, Tennessee (February 10, 1994). The purpose of each seminar was to provide comprehensive, but practical region-specific information on earthquake potential and the characteristics of expected ground shaking, with a special emphasis on issues relevant to the determination and mapping of design ground motions.

This report contains the technical papers presented at the initial five seminars. Specific paper topics included:

- Regional earthquake risk (focused on the region in which the seminar was conducted);
- Implications of new knowledge and new developments for engineering practice (specifically applicable to geotechnical engineering and structural engineering—the design of buildings and bridges).

The complete program for each seminar location, which contains paper titles, authors and panelists, is provided in Appendix A.

Applied Technology Council gratefully acknowledges the many individuals who contributed to the success of the seminar series. Maurice Power, Project Director and Co-Principal Investigator, Charles C. Thiel, Co-Principal Investigator, and Chris D. Poland, Structural Engineering Consultant, developed the seminar program and identified paper authors. Steering Committee members Arthur D. Frankel, Thomas H. Heaton, Thomas L. Holzer (USGS Project Officer), I. M. Idriss, Klaus H. Jacob, William B. Joyner, Helmut Krawinkler, Bijan Mohraz (ATC Board Representative), Allan R. Porush, Paul G. Somerville, Randall G. Updike, and Nabiho Youssef provided overall guidance and direction. The affiliations of these individuals are provided in Appendix B.

Applied Technology Council also gratefully acknowledges the ATC staff for their assistance in planning and conducting the seminar. Patty Christofferson, Manager of Administration and Public Relations, selected the seminar meeting sites and organized the publicity effort. Staff members Karen Johnson and Bernadette Mosby distributed announcements and registered participants.

Christopher Rojahn
ATC Executive Director
Table of Contents

PREFACE .................................................................................................................. i

SEMINAR TECHNICAL PAPERS

Regional Earthquake Risk
Review of Potential Earthquake Sources in Southern California,
   Lucile M. Jones and Egill Hauksson ................................................... 1-1
Seismic Hazard Assessment in the Central United States,
   Arch C. Johnston and Susan J. Nava ......................................................... 2-1
New Knowledge of Northeastern North American Earthquake Potential,
   John Adams and Peter W. Basham .......................................................... 3-1
New Knowledge of Northern California Earthquake Potential,
   David Schwartz ......................................................................................... 4-1
Estimates of Seismic Source Regions from Consideration of the Earthquake
   Distribution and Regional Tectonics in the Pacific Northwest,
   Craig S. Weaver and Kaye M. Shedlock .................................................. 5-1

Strong Ground Motion Estimation
Prediction of Ground Motion in North America,
   David M. Boore and William B. Joyner .................................................... 6-1
Ground Motion Mapping—Past, Present, and Future,
   Arthur Frankel, Paul Thenhaus, David Perkins, and E. V. Leyendecker .... 7-1
Earthquake Ground Motions in the Near Source Region,
   Thomas H. Heaton and Stephen H. Hartsell ........................................... 8-1
Modelling Ground Motions in the Near-Field of Rupturing Faults,
   John Boatwright ...................................................................................... 9-1
New Developments in Estimating Site Response Effects on Ground Motion
   Roger D. Borcherdt .................................................................................. 10-1
New Developments in Estimating Basin Response Effects on Ground Motion
   Arthur Frankel ......................................................................................... 11-1
Three Dimensional Simulations of Ground Motions in the San Bernardino Valley,
   California, for Hypothetical Earthquakes on the San Andreas Fault
   Arthur Frankel ......................................................................................... 12-1
Recent Seismological Insights into the Spatial Variation of Earthquake Ground Motions
   Paul Spudich ......................................................................................... 13-1

Implications of New Knowledge and New Developments for Engineering Practice
Some Recent Site-Specific Ground Motion Evaluations - Southern California
   Examples and Selected Issues
   Yoshiharu Moriwaki, Phalkun Tan, and Paul Somerville ................. 14-1
Utilization of New Developments in Ground Motion Estimation in Engineering
   Design Practice: Examples for Development of Site-Specific Ground Motions
   Maurice S. Power ................................................................................... 15-1
Estimation of Earthquake Ground Motions in the Pacific Northwest
   C. B. Crouse ......................................................................................... 16-1
Implications for the Seismic Design of Buildings
   Chris D. Poland ..................................................................................... 17-1
Seismic Performance Evaluation of Long-Span Bridges
   Roy A. Imbsen and Wen David Liu ..................................................... 18-1
# Table of Contents

<table>
<thead>
<tr>
<th>Page Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>APPENDIX A: ATC-35 SEMINAR PROGRAMS</td>
</tr>
<tr>
<td>B-1</td>
<td>APPENDIX B: ATC-35 PROJECT PARTICIPANTS</td>
</tr>
<tr>
<td>C-1</td>
<td>APPLIED TECHNOLOGY COUNCIL PROJECTS AND REPORT INFORMATION</td>
</tr>
</tbody>
</table>