Participation in the Development of Seismic Provisions for National and Regional Building Codes

by Peter Gergely

Abstract

NCEER researchers have participated in the development or upgrading of several national, state and local seismic design codes. In many cases, NCEER research results have directly contributed to new or improved code proposals, especially with regard to design in moderate seismic zones and the evaluation of existing concrete buildings not designed for seismic loads. Researchers were active in drafting the first seismic code provisions for New York City and New York State. They have also been active on the update of the 1994 National Earthquake Hazard Reduction Program (NEHRP) Recommended Provisions, the ATC-34 project on the Development of Next Generation Seismic Design Approaches for Buildings, the ATC-33 project on Guidelines and Commentary for the Seismic Rehabilitation of Buildings, and a Federal Emergency Management Agency (FEMA) sponsored study on performance-based design.

Collaboration

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Objectives and Approach

The objective of NCEER's participation in a variety of building code activities is to provide expertise, especially information relying on recent NCEER research, to various code-writing groups and organizations, and to perform research to solve problems faced by these groups.

As members of several state or national code-writing bodies, NCEER researchers have directly contributed to drafting new codes or revising existing codes. In several instances, current NCEER research was modified to be more directly useful for codes.

There have been numerous NCEER projects that have contributed to building codes. Tasks 92-3602, 93-3701 and 93-3702 were specifically devoted to building code issues. Other tasks with significant input to building code development include: 87-0001, 93-1701, 93-4101, 93-4102, and 93-4202.

Accomplishments

Many aspects of the Building Project have been concerned with code-type issues, especially problems in zones of moderate seismicity and the evaluation of existing buildings. Both of these topics are currently receiving much attention nationwide. The specific code-type problems studied by NCEER researchers have included: seismicity in the Northeast, especially in New York State; soil amplification and liquefaction; the evaluation of gravity-load designed buildings, the development of simplified analysis methods, reliability studies of codes, nonstructural elements; and energy absorption devices.

In all cases, research has been performed by a number of NCEER researchers from several institutions and mostly with the help of practicing structural engineers. In fact, by its nature, this research effort is problem-focused and is directed toward immediate implementation by code committees.

NCEER researchers have participated in the following code committees or code-writing panels:

- New York City Seismic Code Committee,
- New York State Seismic Code Committee;
- NEHRP (National Earthquake Hazard Reduction Program), Recommended Provisions for the Development of Seismic Regulations for New Buildings (both on the Provisions Update Committee and on its Technical Subcommittees);
- ATC-34 Development of Next Generation Seismic Design Approaches for Buildings;
- FEMA/ATC/BSSC Guidelines and Commentary for the Seismic Rehabilitation of Buildings; and
- FEMA/Berkeley Problem-Focused Study on Performance Based Seismic Design of Buildings.

In addition, NCEER researchers have participated in an ad-hoc manner in other code activities, such as the Uniform Building Code (UBC), Structural Engineers Association of California (SEAOC), and the Eurocode 8. NCEER sponsored a project to modify and greatly expand the ATC-14 document "Evaluating the Seismic Resistance of Existing Buildings" to adapt the methodology for the seismic evaluation of existing buildings currently used in areas of high seismicity to areas of low to moderate seismicity. As a result of this project, involving mainly practicing engineers and headed by C. Poland and J. Malley of H.J.

Degenkolb Associates, an NCEER report titled "Recommended Modifications to ATC-14" (Polland and Malley, 1989) was published which concentrates on construction practice on the east coast and midwest. These recommendations were incorporated into another NCEER report, "A Procedure for the Seismic Evaluation of Buildings in the Central United States" (Poland and Malley, 1992).

Much of the contributions in code development occurs during committee meetings and in writing or commenting on code drafts. Naturally, it is not possible to summarize those efforts completely, though they are just as important and valuable as the development of specific new code proposals In fact, in most cases, NCEER researchers were invited to serve on code committees because of their current work on NCEER-sponsored projects

This summary of code-related activities concentrates on structural aspects of buildings. Other summaries cover nonstructural components, bridges, and some seismicity issues, as well as masonry buildings (see related papers in this volume).

Building Seismic Safety Council/National Earthquake Hazard Reduction Program Activities

NCEER researchers participated in four areas of the 1994 update of the 1991 NEHRP Recommended Provisions for the Development of Seismic Regulations for Buildings. Major input was provided to the seismic zonation task, especially for the northeastern United States and New York State The NCEER ground motion database was used to significantly revise seismicity estimates, and the contributions extended to methodology, the treatment of rare large earthquakes, and the creation of spectral ordinate maps.

The soil factors were completely revised with the help of NCEER researchers and partly following the example set for the New York State Seismic Code (see paper Earthquake Site Response and Seismic Code Provisions in this volume).

Since the NEHRP Recommended Provisions apply nationwide, NCEER researchers were helpful in providing an east-coast perspective with regard to different construction practices and problems specific to areas of moderate seismicity. The load-reduction (so-called R) factors were modified for ordinary and intermediate moment resisting frames based on NCEER experimental and analytical research

A completely new chapter on composite construction was added to the 1994 update to cover the seismic design of buildings built of elements made of steel and concrete. An NCEER researcher was asked to be the leader of the team in charge of this major effort. Computer programs developed or extended during the early years of NCEER were utilized for selecting some of the technical parameters.

Likewise, major input was provided by NCEER researchers to a new chapter on base isolation and energy dissipation, and to a substantial revision of the nonstructural and equipment chapter. These contributions resulted directly from NCEER research (see Code Development for Nonstructural Components in this volume).

In addition to participating in the work of the various teams, two NCEER researchers were also on the Provisions Update Committee, which oversees the revision process and votes on all modifications and additions to the code.

New York City and New York State Seismic Code Proposals

Two NCEER researchers were invited to be members of the code committees to add seismic provisions to first the New York City and then the New York State building codes. This is the first time that either of these codes have drafted seismic design provisions and it is probably the first time that a code has been developed in the east-

ern U.S. that is not primarily an adoption of one of the national model codes. Many new ideas and requirements were drafted with strong NCEER contributions. Among these are: the development of a seismic zonation map for the State, the establishment of the seismic risk in New York City, the construction of rules for soil liquefaction, and the generation of new soil amplification factors which are significantly different from those in national codes. (Furthermore, the NEHRP Recommended Provisions and other guidelines have since introduced soil factors similar to those in the New York City/New York State proposals).

NCEER researchers have proposed numerous new features or modifications to existing code provisions. These include rules for moderate seismic zones (which are not well treated in existing national model codes), some exemptions to requirements for ordinary and intermediate frames, changes in the R factors, changes in rules for building separation, and requirements for selection of analysis methods.

Applied Technology Council - Critical Code Issues, ATC-34

It has been recognized that current national seismic codes need to be revised thoroughly because they have been altered and patched in an ad-hoc manner for about thirty years. Some of the shortcomings can be remedied only with a radically new code format and approach. Therefore, NCEER has sponsored a project titled "Critical Code Issues" with the leadership of the Applied Technology Council, which has established a blue-ribbon Project Engineering Panel. Its members are: V. Bertero, I. Buckle, S. Freeman, P. Gergely, G. Hart, H. Krawinkler, R. Mayes, A. Meirovich, J. Nicoletti, G. Nordenson, M. Shinozuka, and J. Theiss. The Principal Investigator is C. Rojahn and the Project Director is A. Whittaker. The initial goal was to study the response modification factors (R factors) in current codes and to recommend studies to improve the use and the values of these factors.

The Project Engineering Panel started with intense discussions about what such a project can and should do. It recommended to broaden the scope of the project from a study of only the R factors to a more general evaluation of codes. What are the main deficiencies of current codes and what would be the most desirable features of an ideal code?

Therefore, the first year of Phase 2 of the project concentrated on a critical review of current approaches to earthquake-resistant design. A report has been drafted and reviewed by the Project Engineering Panel. It contains a historical review of code developments, a review and critique of code approaches, studies needed to improve current seismic design practice, and the key features of a new model code.

NCEER input to this project is not limited to sponsorship. Four current or former NCEER researchers serve on the Project Engineering Panel and two researchers are project consultants. Technical expertise and input have been provided in a number of areas, including risk and reliability-based design, evaluation of R factors, special characteristics of design in moderate seismic zones, performance-based design, response reduction factors, and probabilistic design concepts.

This project was initiated in 1990. Since then, there have been a number of national or regional groups studying new design approaches. These include Vision 2000 in California, FEMA/BSSC/ATC on Rehabilitation (see below), and a short problem-focused study sponsored by the Federal Emergency Management Agency. Members of the NCEER/ATC-34 project serve on these other projects and close interaction in terms of transfer of knowledge or findings is assured. In fact, the NCEER/ATC-34 project was a small step ahead in taking a critical look at codes and examining novel approaches. Overlap between the various code studies is at a desirable level.

FEMA/BSSC/ATC Guidelines and Commentary for the Seismic Rehabilitation of Buildings, ATC-33

The Federal Emergency Management Agency is sponsoring a major effort to develop Guidelines and Commentary for the Seismic Rehabilitation of Buildings. Several NCEER researchers have been asked to join the various technical teams. They serve on teams concerned with General Requirements, Analysis Methods, Geotechnical/ Foundations issues, Concrete (advisory member), Masonry, Wood, and New Technologies. The Leader of the Team on Masonry structures is Professor Daniel Abrams. NCEER research results are utilized by most teams because rehabilitation involves the assessment of existing buildings, which has been one of the main research focuses of NCEER. Among the areas where recent NCEER research or researchers assist this project are. performance-based design concepts, behavior of concrete elements, soil issues, analysis methods, nonstructural elements, masonry buildings and new technologies (base isolation and dampers).

FEMA Problem-Focused Study on Performance Based Seismic Design of Buildings

The Federal Emergency Management Agency sponsored a project led by researchers at the University of California at Berkeley, to propose an action plan for the study of performance based seismic design of buildings. A number of NCEER researchers have been asked to assist this project as members of the issues identification team, project review panel, and writers of straw man issue papers. In addition, eight NCEER researchers were invited to participate in a colloquium as part of this project. Performance-based design must rely on performance (or damage) indices and on reliability concepts which have been studied by NCEER researchers.

Personnel and Institutions

The NCEER researchers who have participated in code activities include Greg Deierlein and Peter Gergely, Cornell University; Ricardo Dobry, Rensselaer Polytechnic Institute; Klaus Jacob, Lamont-Doherty Earth Observatory; Ian Buckle and Tsu T. Soong, University at Buffalo; M. Shinozuka, Princeton University; Daniel Abrams, University of Illinois at Urbana-Champaign; and Geoffrey Martin, University of Southern California.

In addition, NCEER researchers have worked in close collaboration with practicing engineers on the various code committees and with code officials. Several other engineers, most notably Glenn Bell, Simpson, Gumpertz and Heger; Jacob Grossman, Robert Rosenwasser Associates; and Thomas Sabol, Engelkirk and Sabol; acted as project consultants to some of the research investigations.

Technical References

ATC, "A Critical Review of Current Approaches to Earthquake-Resistant Design," ATC-34, Applied Technology Council, Final draft, July 1994

Building Seismic Safety Council, "NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings," 1994 draft, Federal Emergency Management Agency.

EERC, "Performance Based Seismic Design of Buildings," an Action Plan for Future Studies, Earthquake Engineering Research Center, prepared for the Federal Emergency Management Agency, final draft, July 1994.

"Guidelines and Commentary for the Seismic Rehabilitation of Buildings," FEMA/ATC/ASCE, 50% Draft, August 1994

New York City Seismic Code, Final Draft, Administrative Code, City of New York, April 1991.

New York State Seismic Provisions, New York State Uniform Fire Prevention and Building Code, Final Draft, April 1993

Poland, C.D , and Malley, J O., "Recommended Modifications to ATC-14," Technical Report NCEER-89-0012, National Center for Earthquake Engineering Research, University at Buffalo, April 12, 1989.

Poland, C.D. and Malley, J O., "A Procedure for the Seismic Evaluation of Buildings in the Central and Eastern United States," Technical Report NCEER-92-0008, National Center for Earthquake Engineering Research, University at Buffalo, April 2, 1992