

Project Profile

(updated 11/08/04)

Introduction

The Applied Technology Council (ATC), with funding provided by the Federal Emergency Management Agency (FEMA), is working on a project to evaluate and improve the application of simplified inelastic analysis procedures for use with performance-based engineering methods for seismic design, seismic evaluation, and seismic rehabilitation of buildings.

There has been a large national investment in performance-based engineering because of the prospect of simultaneously improving seismic design practices. The future effective use of performance-based engineering depends on reliable and credible inelastic analysis procedures. The ATC-55 project provides a practical and effective way to resolve differences, incorporate new knowledge, and build consensus and guidance for the improvement of these procedures as they are applied to both existing and new structures.

In 1996 ATC, with funding from the California Seismic Safety Commission, published the ATC-40 report: *Seismic Evaluation and Retrofit of Concrete Buildings*. The report, FEMA 273 *Guidelines for the Seismic Rehabilitation of Buildings* was prepared by ATC (for the Building Seismic Safety Council) and issued in 1997 (A *Commentary* was issued simultaneously as FEMA 274). Each document presents a performance-based engineering method that relies on a nonlinear static analysis procedure (NSP). The two approaches are essentially the same when it comes to generating a "pushover" curve to represent the lateral capacity of a building. They differ, however, in the technique used to calculate the inelastic displacement demand for a given ground motion. FEMA 273/274 uses a procedure that has come to be known as the Displacement Coefficient Method and ATC-40 details the Capacity Spectrum Method. The use of NSPs has accelerated since the publication of ATC-40 and FEMA 273. There is consequently valuable information available on the practical application of these inelastic analysis procedures. In practice, engineers have found that in some cases different inelastic analysis methods give substantially different estimates for displacement demand and capacity for the same ground motion and building. The disparities in displacement predictions highlight the need for comparison and further study of these different approaches. Such studies would provide guidance to structural engineers in the effective use of inelastic analysis procedures. Concurrent with the development and initial applications of these performance-based methods, ongoing research portends important modifications, improvements, and alternatives to current NSPs.

Purpose and Objectives

The objectives of the ATC-55 project are:

1. Improved understanding of the inherent assumptions and theoretical underpinning of existing and proposed new simplified analysis procedures.
2. Recognition of the applicability, limitations, and reliability of the procedures.
3. Guidelines for practicing engineers to apply the procedures to new and existing buildings.
4. Direction for researchers on issues for future improvement of simplified inelastic analysis procedures.

The results of the project will include a project document to be published by FEMA. This document will provide a comprehensive discussion of inelastic seismic analysis of new and

existing buildings. It will contain guidelines for applications of selected procedures including their specific strengths, weaknesses and limitations. The document will also contain illustrative examples and expert commentary on key issues.

Approach

The project encompasses a variety of efforts, including: identification and development of major issues impacting improved use of inelastic analysis procedures; information and data gathering; data analysis and synthesis; the resolution of major issues and the identification of research needs; the development of guidance to practicing engineers for improved use of existing and proposed procedures; and the documentation of project findings in suitable reports and engineering applications.

Phase I, which was completed on November 1, 2001, focused on the assembly and refinement of important issues relating to the improvement of inelastic seismic analysis procedures. Activities included the solicitation of input from researchers and practicing engineers. Another objective of Phase I was to develop study models of typical buildings to stimulate discussion, facilitate analytical studies, and provide example applications. As a result of the process, key issues requiring analytical study will be identified for investigation.

Phase II consists of analytical studies to explore selected key issues, and the establishment of focus groups to explore and discuss important topics. This effort culminated with the assembly of an initial set of guidelines for the improved implementation in practice of the simplified procedures.

Phase III, scheduled for completion in March 2005, includes the development, revision and finalization of the FEMA 440 report, *Improvement of Nonlinear Static Seismic Analysis Procedures*, which contains (1) guidelines for improved application of the Coefficient Method, as detailed in the FEMA-273 and FEMA-274 *Guidelines and Commentary for the Seismic Rehabilitation of Buildings*, (2) guidelines for improved application of the Capacity Spectrum Method, as detailed in the ATC-40 Report, *Seismic Evaluation and Retrofit of Concrete Buildings*, and (3) other related guidance of interest to design practitioners and researchers. Under *Phase III*, ATC will also conduct a series of three training seminars to advise practicing structural engineering professionals on the guidance developed under the ATC-55 project. Seminars are planned for Los Angeles, San Francisco, and Seattle.

Personnel and Management

The project is administered by ATC through its Executive Director, Christopher Rojahn, who also serves as Principal Investigator (PI). Day-to-day activities on the project are managed and guided by Craig Comartin (ATC Senior Structural Consultant, Stockton, California), who serves as co-PI and Project Director. A Project Management Committee comprised of the PI, Co-PI, Ronald Hamburger (ABS Consulting, Oakland, California), William Holmes (Rutherford and Chekene, Oakland, California), Wilfred Iwan (California Institute of Technology, Pasadena, California), Jack Moehle (Pacific Earthquake Engineering Research Center, U.C. Berkeley, Richmond, California) and Jonathan Stewart (University of California at Los Angeles), has responsibility for managing and solving the technical aspects of the project. A Project Review Panel, consisting of Anthony Court (Curry Price Court, San Diego), Leonard Joseph (Thornton-Tomasetti Engineers, New York), Daniel Shapiro (SOHA Engineers, San Francisco), Steve Sweeney (U.S. Army Engineer Research and Development Center, Champaign, Illinois), Chia-Ming Uang (University of California at San Diego), and Michael Valley (Skilling Ward Magnusson Barkshire, Seattle), provides overview and technical guidance for the project.

Detailed work on Phase I of the project has been carried out by the Phase I Project Working Group: Joe Maffei (Consulting Structural Engineer, Oakland), Mark Aschheim (University of Illinois at Urbana-Champaign), Maureen Coffey (Rutherford & Chekene, Oakland), and Mason Walters (Forell/Elsesser Engineers Inc., San Francisco). Detailed work on Phase II of the

project has been carried out by the Phase II Project Working Group: Sinan Akkar (graduate student, Stanford University), Mark Aschheim (University of Illinois at Urbana-Champaign), Andrew Guyader (Graduate student, California Institute of Technology), Eduarde Miranda (Stanford University), and Jorge Ruiz-Garcia (graduate student, Stanford University).

During Phase II, input was also provided by the following four focus groups:

- **Focus Group on Displacement Modification:** John Hooper (Skilling, Ward, Magnesson, & Barkshire, Seattle Washington), Gregory MacRae (University of Washington, Seattle), and Stephen Mahin (University of California at Berkeley).
- **Focus Group on Equivalent Linearization:** Terrence Paret (Wiss, Janney, Elstner Associates, Oakland), Graham Powell (Graham H. Powell, Inc., Danville California), and Andrew Whittaker (University at Buffalo, SUNY)
- **Focus Group on Multi-Degree-of-Freedom Effects:** Anil Chopra (University of California at Berkeley), Jon Heintz (Degenkolb Engineers, San Francisco), and Helmut Krawinkler (Stanford University)
- **Focus Group on Short Period Buildings:** Jacobo Bielak (Carneige Mellon University), Greg Fenves (University of California at Berkeley), and James O. Malley (Degenkolb Engineers, San Francisco)

A key aspect of the project is the active input of interested and qualified researchers and engineering practitioners. These participants, solicited at the beginning of the project, are to be informed of the progress of the work and provided opportunities for ongoing input. This communication is solicited principally through this project website, as described below.

ATC-55 Website Registration

Earlier in the project ATC created an ATC-55 project website to serve as the primary communication mechanism for the project. Persons interested in project findings and in providing information and review comments to the project were provided with an opportunity to register on the project web site and to download project documents, which could then be returned with comments by email. This list of web site registrants has been maintained and will be used to notify participants of the posting of the final camera-ready report and of the time and location of project seminars. ATC gratefully acknowledges the important contributions made by the individuals who participated in this important process.

The ATC-55 Web Site will remain open until at least March 2005. Persons wishing to register on this web site can do so on the ATC-55 Project page under "Active Projects" at www.atccouncil.org.