SAC
Steel Project

Background Document

Survey of Computer Programs for the Analysis of Steel Moment Frame Structures

Report No. SAC/BD-96/04

SAC Joint Venture
A partnership of
Structural Engineers Association of California (SEAOC)
Applied Technology Council (ATC)
California Universities for Research in Earthquake Engineering (CUREe)

By

Results of a Survey Undertaken in Support of the System Performance Tasks of the Phase II SAC Steel Project

Submitted for distribution to
SAC Joint Venture
650-595-1542
http://www.sacsteel.org

September 1996

DISCLAIMER

This document is one of a series documenting background information related to Phase II of the FEMA-funded SAC Steel Project. It is being disseminated in the public interest to increase awareness of the many factors which contribute to the seismic performance of steel moment frame structures. The information contained herein is not for design use and is not acceptable to specific building projects. This report has not been reviewed for accuracy, and the SAC Joint Venture has not verified any of the results presented. **No warranty is offered with regard to the recommendations contained herein, by the Federal Emergency Management Agency, the SAC Joint Venture, the individual joint venture partners, or the partner's directors, members or employees. These organizations and their employees do not assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any of the information, products or processes included in this publication. The reader is cautioned to review carefully the material presented herein and exercise independent judgment as to its suitability for application to specific engineering projects.** This publication has been prepared by the SAC Joint Venture with funding provided by the Federal Emergency Management Agency, under contract number EMW-95-C-4770.

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THE SAC JOINT VENTURE

SAC is a joint venture of the Structural Engineers Association of California (SEAOC), the Applied Technology Council (ATC), and California Universities for Research in Earthquake Engineering (CUREe), formed specifically to address both immediate and long-term needs related to solving performance problems with welded, steel moment-frame connections discovered following the 1994 Northridge earthquake. SEAOC is a professional organization composed of more than 3,000 practicing structural engineers in California. The volunteer efforts of SEAOC's members on various technical committees have been instrumental in the development of the earthquake design provisions contained in the *Uniform Building Code* and the 1997 *National Earthquake Hazards Reduction Program (NEHRP) Recommended Provisions for Seismic Regulations for New Buildings and other Structures*. ATC is a nonprofit corporation founded to develop structural engineering resources and applications to mitigate the effects of natural and other hazards on the built environment. Since its inception in the early 1970s, ATC has developed the technical basis for the current model national seismic design codes for buildings; the *de facto* national standard for postearthquake safety evaluation of buildings; nationally applicable guidelines and procedures for the identification, evaluation, and rehabilitation of seismically hazardous buildings; and other widely used procedures and data to improve structural engineering practice. CUREe is a nonprofit organization formed to promote and conduct research and educational activities related to earthquake hazard mitigation. CUREe's eight institutional members are the California Institute of Technology, Stanford University, the University of California at Berkeley, the University of California at Davis, the University of California at Irvine, the University of California at Los Angeles, the University of California at San Diego, and the University of Southern California. These laboratory, library, computer and faculty resources are among the most extensive in the United States. The SAC Joint Venture allows these three organizations to combine their extensive and unique resources, augmented by subcontractor universities and organizations from across the nation, into an integrated team of practitioners and researchers, uniquely qualified to solve problems related to the seismic performance of steel moment-frame buildings.

ACKNOWLEDGEMENTS

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PREFACE

As part of the System Performance Tasks in the Phase II Steel Project, the SAC Project Management Committee distributed a survey to numerous academic and commercial software developers requesting specific information about the suitability of their products for the analysis of steel moment frame structures. The respondents were asked to specifically address the following Issues:

- Whether the program can be used for local (connection) and/or global (system) analysis
- Whether the program can be used to model 2D and/or 3D behavior
- Existing element models
- Methods of analysis: linear static, linear dynamic, nonlinear static (i.e. pushover), nonlinear dynamic, etc.
- Flexibility in implementing different nonlinear element models, including elements which can reproduce stiffness and/or strength degradation/deterioration
- Ability to model post-fracture behavior of connections
- Ability to model behaviors typical of steel frames such as local buckling, panel zone strength and deformation, column splice fracture, interaction between beams and slabs, etc.
- Ability to model geometric nonlinearities (e.g. P-delta effects)
- Ability to model partially restrained connections
- Ability to model distributed plasticity
- Implementation of fracture mechanics concepts
- Ability to model energy dissipation devices
- Pre- and post-processing capabilities, model generation facilities, etc.
- Computer platform(s) / operating system(s) required
- Availability of source code – if not public domain, documentation of element formulations, solution procedures, etc.
- Validation or quality assurance that has been performed
- Publications describing this software

A total of 18 submittals from 14 different individuals or organizations are summarized in this document. The following table lists the surveys received:

Program(s)	Contact	Program(s)	Contact	Program(s)	Contact
RUAMOKO	A. J. Carr	Modified DRAIN-2DX	D. Foutch	NIKE3D DYNA3D	D. McCallen
CU-DYNAMIX	G. Deierlein	FRANC2D FRANC3D	T. Ingraffea & G. Deierlein	ANACAP-S (2D and 3D)	R. Dunham
DRAIN-2DX DRAIN-3DX	S. Campbell	SNAP-2D	S. Goel	DRAIN-2D+	K. C. Tsai
IDARC2D	A. Reinhorn	SC-Push3D	G. Loy	ADINA	G. Loy
GT STRUDL	G. Loy	IDASS	S. Kunnath	CFTmacro	J. Hajjar
CFTfiber	J. Hajjar	Planar analysis of steel frames	J. Hall	PC-ANSTR	B. Maison