SAC
Steel Project

Background
Document

Round-Robin Testing of Ultrasonic Testing Technicians

Report No. SAC/BD-00/06

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
Robert E. Shaw, Jr., P.E.
Steel Structures Technology Center, Inc.
42400 W. Nine Mile Road, Suite 8
Novi, Michigan 48375

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

August 22, 2000

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.

SAC
Steel Project

Background
Document

Round-Robin Testing of Ultrasonic Testing Technicians

Report No. SAC/BD-00/06

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
Robert E. Shaw, Jr., P.E.
Steel Structures Technology Center, Inc.
42400 W. Nine Mile Road, Suite 8
Novi, Michigan 48375

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

August 22, 2000

SAC
Steel Project

Background
Document

Round-Robin Testing of Ultrasonic Testing Technicians

Report No. SAC/BD-00/06

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
Robert E. Shaw, Jr., P.E.
Steel Structures Technology Center, Inc.
42400 W. Nine Mile Road, Suite 8
Novi, Michigan 48375

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

August 22, 2000

PREFACE

The primary objectives of the FEMA/SAC Phase 2 Steel Project are to develop guidelines for the seismic evaluation, inspection, repair, design and construction of moment-resisting steel frame buildings. A diverse collection of technical investigations is supporting this effort, including the identification of basic material properties in rolled steel sections; development of appropriate welding materials, details, and inspection procedures; specification of anticipated seismic demands imposed on connections as a result of structural response to strong ground motions; and large-scale connection testing to calibrate and verify the design procedures that are ultimately proposed. Tying these activities together is a series of detailed finite element analyses of various connection configurations to quantify the influence of material properties, geometry, and detailing on predicted behavior. In addition, a series of studies have been performed to incorporate the results of the various investigations into a performance-based seismic engineering format that can become the basis of the SAC guidelines. Cost and risk studies and investigations into the past performance of this class of structures were also performed to gather valuable information used in the development of the guidelines and other documents.

This report was carried out to support the development of inspection guidelines and the overall efforts of the Welding and Inspection team of the SAC Phase 2 Steel Project. Th Welding and Inspection team was responsible for assessing the factors that effect the behavior of complete joint penetration welds of the type used in steel beam to column connections, assessing the ability of nondestructive evaluation methods to detect and characterize weld defects, and developing weld acceptance criteria considering the properties of the welds, the applied deformations or stress conditions, and likely local defects and imperfections. A variety of tests, theoretical studies and finite element analyses were conducted as part of this task. The work in this task was closely linked to parallel efforts and full size connections tests carried out by the Connection Performance and Materials and Fracture teams.

This report summarizes the findings of a series of ultrasonic test (UT) inspections conducted by different inspectors from various independent inspection agencies. This effort was intended to assess the reliability of current UT inspection methods in detecting and sizing defects in a welded joint, and thereby help establish weld acceptance criteria. A series of weld mock-ups (see SAC/BD-99/05), representative of various conditions in pre-and post-Northridge welded beam to column connections, were fabricated with well-defined defects positioned in documented locations. Inspectors were not provided information on the nature and location of the defects. Statistics are presented on missed defects and false calls. The number of inspections performed and test conditions do not allow these results to be considered representative of actual field practices. This project was identified as Task 8.01 in the SAC Phase 2 work plan.

Numerous individuals helped to develop the scope and content of this project and to review a preliminary version of this report. These individuals included members of the Technical Advisory Panels (TAP) for Welding and Inspection and Connection Performance; the Project Management Committee, and several members of the Project Oversight Committee. The contributions of these individuals are greatly appreciated.

Project Summary

The quality and accuracy of the ultrasonic testing of structural steel connections has been drawn into question. Several issues have been addressed through the use of round-robin testing of mock-up specimens representative of a variety of common steel joints used in steel moment frames. The specimens were fabricated with embedded discontinuities of known size, location and orientation. These specimens were then examined by a number of ultrasonic testing technicians, and the test results submitted for analysis.

Questions to be answered included:

1. How reliable and consistent are UT results between UT technicians using the same standards?
2. How often are weld discontinuities and defects missed?
3. How often are indications reported that are not related to weld discontinuities (false calls)?
4. Are weld discontinuities in particular locations more likely to be missed?
5. Are particular joint details susceptible to poor UT reliability or consistency?
6. Is there a lower bound dimensional threshold below which UT will not detect the discontinuity?
7. What is the accuracy to which UT technicians can determine discontinuity location and length?
8. Have practicing UT technicians developed special techniques for addressing difficult situations such as backing bars and beam web interference?