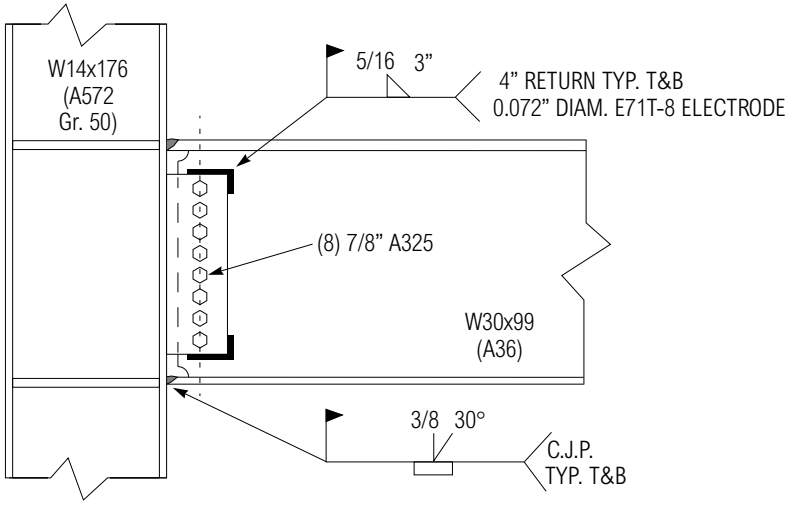
SAC Steel Project

Test Summary No. 1

the FEMA Program to Reduce the Earthquake Hazards of Steel Moment Frame Structures

Specimen ID:	EERC-PN1
Keywords:	Pre-Northridge, simulated field welding, panel zone yielding, weld fracture, small rotation capacity
Test Location:	Earthquake Engineering Research Center, University of California at Berkeley
Test Date:	March 7, 1995
Principal Investigator:	Vitelmo V. Bertero; with Andrew S. Whittaker and Amir S. Gilani
Related Summaries:	13, 14
Reference:	"Experimental Investigations of Beam-Column Subassemblages," *Report No. SAC 96-01*, March 1996.
Funding Source:	FEMA / SAC Joint Venture, Phase I

CONNECTION DETAIL



MATERIAL PROPERTIES AND SPECIMEN DETAILS

Member	Size	Grade	Yield Stress (ksi)		Ultimate Strength (ksi)	
			mill certs.	coupon tests*	mill certs.	coupon tests*
Beam	W30X99	A36	54.1	50.3 flange 55.7 web	73.4	70.9 flange 71.9 web
Column	W14X176	A572 Gr. 50	56.5	50.0 flange 49.5 web	74.5	69.0 flange 69.5 web

Welding Procedure Specification	All welds FCAW-SS in conformance with AWSD1.1-94, performed with 0.120" diameter AWS E70T-4 electrodes. Preheat and interpass temperature per Table 4.3. Fillet weld of shear tab to beam web performed with 0.072" diameter AWS E71T-8 electrode.
Shear tab	1/2" × 4-1/2" × 23-5/8" plate with eight 7/8" A325 bolts
Panel zone	No doubler plates
Continuity plates	3/8" plates with CJP groove weld
Boundary conditions	Single-sided test, no floor slab, axial load in lower half of column equal to shear in beam, specimen tested in upright position
Other detailing	Connection between column and beam welded in the upright position

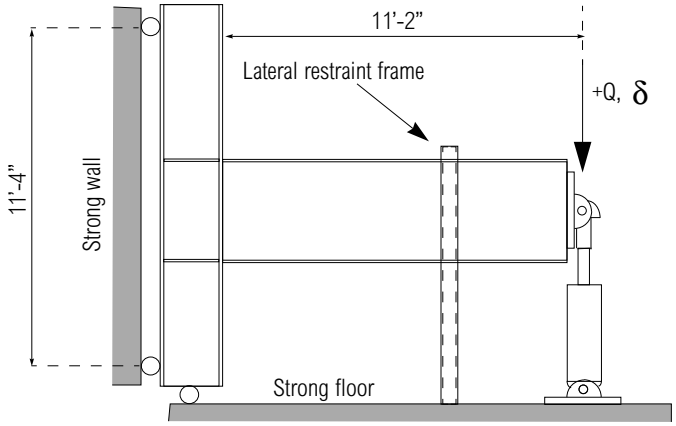
*Coupon locations per ASTM

BACKGROUND

The objectives of testing the Pre-Northridge specimens were to replicate in the laboratory the failure modes observed in the field after the Northridge earthquake to develop a better understanding of the failure mechanisms, and to acquire data on the likely deformation characteristics of beam-column connections constructed to industry standards before 1994. The specimen described in this summary was fabricated under controlled conditions by a local commercial steel fabricator to details specified by SAC and the principal investigator. It was intended to be identical to the specimens described in Test Summaries No. 2 and 3. In addition, these were intended to be nearly identical to the specimens described in Test Summaries No. 4, 5, and 6 which were tested at U.C. San Diego. Because each of these were fabricated under controlled conditions, however, it is possible that their quality is superior to typical moment connections fabricated in the field prior to the Northridge earthquake. As such, some field-fabricated moment connections may exhibit less rotation capacity than these test specimens.

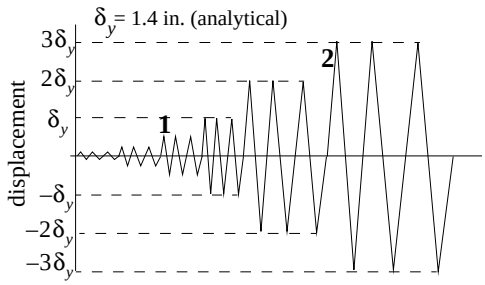
The standard SAC/ATC-24 loading history was used in the quasi-static testing of the specimen. The yield displacement (δ_y) of the specimen was calculated from nonlinear analysis to be 1.40 in.

TEST SET-UP



DISPLACEMENT HISTORY AND KEY EXPERIMENTAL OBSERVATIONS

Applied Displacement History



Key Observations of the Test

Point	Description
1	Shear yielding in the panel zone (displacement = $0.75\delta_y$)
2	Fracture of welded connection of beam top flange to column flange during first excursion to $3\delta_y$.

DETAILED TEST RESULTS

Quantity (see Introduction for definitions used in EERC tests)		Maxima
Force/Displacement Properties	Peak actuator force (kips):	110
	Beam deformation (in.):	1.7
	Experimental beam yield displacement (in.)	1.2
Rotation Capacity	Maximum plastic rotation (% radian):	1.1
	Cumulative plastic rotation (% radian):	NA
Energy Dissipation Properties	Cumulative energy dissipated (k-in.):	464

Mode of failure: Fracture of the welded beam top flange to column flange connection during the first half-cycle of loading to $3\delta_y$.

DISCUSSION

Specimen EERC-PN1 failed during the first half-cycle of loading to a displacement of $3\delta_y$. Failure occurred in the groove welded connection of the beam top flange to the column flange at a beam tip displacement of approximately 0.1 in. during the excursion. Failure of the specimen was preceded by shear yielding in the panel zone, initally observed during the first displacement cycle to $0.75\delta_y$. The specimen failed abruptly during the $3\delta_y$ cycle. Data from the strain gages on the top-side of the top flange of the beam indicated flexural strains exceeding 20,000 microstrain. However, visual inspection of the specimen following the testing suggested that there was little plastification over the depth of the beam. The maximum plastic rotation of the connection prior to failure was approximately 1.1% radian: 0.7% radian in the panel zone, and 0.4% radian in the beam. The panel zone dissipated substantially more energy than the beam.