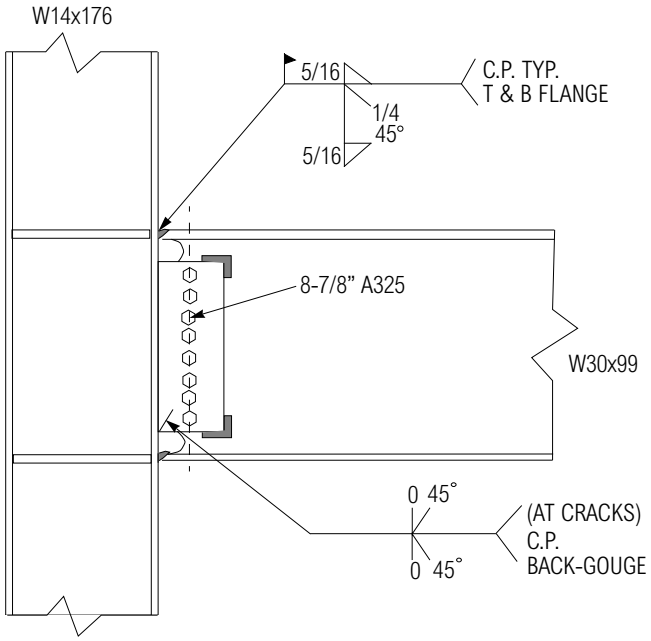
SAC Steel Project

Test Summary No. 14

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

Specimen ID:	EERC-RN1A
Keywords:	Repair, notch-tough electrode material, panel zone yielding, weld fracture, small rotation capacity
Test Location:	Earthquake Engineering Research Center, University of California at Berkeley
Test Date:	August 8, 1995
Principal Investigator:	Vitelmo V. Bertero; with Andrew S. Whittaker and Amir S. Gilani
Related Summaries:	1, 13
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 AWS D1.1-94. Original bottom flange groove weld performed with 0.120" diameter AWS E70T-4 electrode. Bottom flange replacement groove weld performed with 0.072" diamter 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 c.p. weld
Boundary conditions	Single-sided test, no floor slab, axial force in lower half of column equal to beam shear force, specimen tested in upright position
Other detailing	Remove and replace fractured bottom flange groove welds; back-gouge groove welds at top and bottom flanges, remove B.U. bars, place reinforcing fillet welds

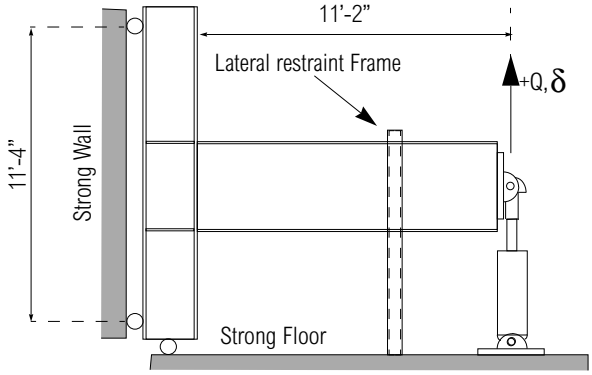
*Coupon locations per ASTM

BACKGROUND

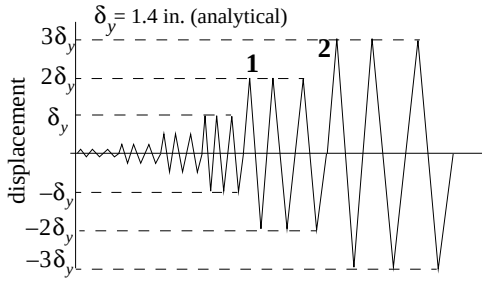
This was the third test of specimen EERC-PN1 (Test Summary No. 1) that was originally tested on March 7, 1995, and then repaired and tested again as specimen EERC-RN1 (Test Summary No. 13) on July 10, 1995. The original specimen experienced a sudden fracture of the weld between the beam top flange and the column flange during the first positive displacement excursion to $3\delta_y$ (where, δ_y = 1.40 in., was obtained from analytical studies of the original specimen). The first test of the repaired specimen resulted in a sudden fracture of the weld between the beam bottom flange and the column flange during the second positive displacement excursion to $2\delta_y$. Neither the original specimen nor the initially repaired specimen exhibited any significant plastic deformations or rotations. The failure of both specimens was preceded by shear yielding in the panel zone. Visual observation of both specimens following testing suggested that there was little plastification in the beam. The cyclic tests were performed quasi-statically.

The second repair of the specimen consisted of removing the fractured bottom flange weld material and replacing it with a complete penetration groove weld composed of notch-tough filler metal, back-gouging the root pass of the new bottom flange groove welds, and placing a reinforcing fillet weld in the back-gouged zone to reinforce the groove weld. The standard SAC/ATC-24 loading history was used in the quasi-static testing of the repaired specimen.

TEST SET-UP



DISPLACEMENT HISTORY AND KEY EXPERIMENTAL OBSERVATIONS



Key Observations of the Test

Point	Description
1	Shear yielding in the panel zone
2	Fracture of the welded connection between the beam bottom flange and the column flange

DETAILED TEST RESULTS

Quantity (see Introduction for definitions used in EERC tests)		Maxima
Force/Displacement Properties	Peak actuator force (kips):	121
	Beam deformation (in.):	1.5
	Experimental beam yield displacement (in.)	1.1
Rotation Capacity	Maximum plastic rotation (% radian):	1.0
	Cumulative plastic rotation (% radian):	NA
Energy Dissipation Properties	Cumulative energy dissipated (k-in.):	387

Mode of failure: Fracture of the groove weld between the beam bottom flange and the column flange during the first positive displacement excursion to $3\delta_y$ cycle.

DISCUSSION

Specimen EERC-RN1A failed during the first positive displacement excursion to $3\delta_y$. The groove weld between the beam bottom flange and the column flange fractured at a beam tip displacement of approximately 3.0 in. Failure of the specimen was preceded by shear yielding in the panel zone, first observed during the first displacement cycle to $1\delta_y$. Visual inspection of the underside of the bottom flange of the beam indicated that the failure was likely initiated at the underside of the beam web and propagated out towards the edges of the flange. There was little evidence of yielding in the beam. The maximum plastic rotation of the connection prior to failure was approximately 0.010 radian, consisting of 0.007 radian from the panel zone, and 0.003 radian from the beam. The beam plastic rotations for this specimen were of the same order of magnitude of the original and the first repaired specimen, even though notch-tough electrodes were used in both beam flange-to-column flange welds. Therefore, the results of the test do not provide evidence that the use of notch-tough electrode material will enhance the seismic performance of the beam-column connections.