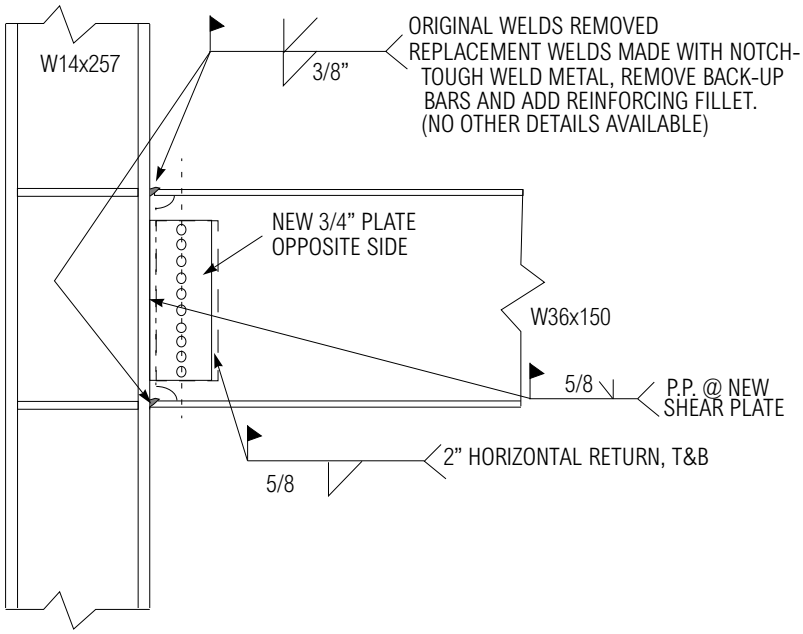
SAC Steel Project

Test Summary No. 26

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

Specimen ID:	UCB-RN3
Keywords:	Repaired, new shear tab, beam yielding, top and bottom flange cracking, medium rotation capacity
Test Location:	University of California, Berkeley
Test Date:	July 20, 1995
Principal Investigator:	Egor P. Popov; with Marcial Blondet, Lev Stepanov, and B. Stojadinovic
Related Summaries:	12
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	W36x150	A36	56.8	40.6 flange 49.6 web	68.7	57.4 flange 60.7 web
Column	W14x257	A572 Gr. 50	53.5	48.3 flange N.A. web	72.5	67.8 flange 76.1 web

Welding Procedure Specification	Original welds: WPS given in Test Summary No. 10. Repair welds: conforms with AWS D1.1-94 and be capable of delivering a minimum of 20 ft-lbs at 20 F as measured by a Charpy V-Notch impact test; no other details available
Shear tab	New 3/4"x4"x30" plate on the opposite side of original, original bolts removed
Panel zone	No doubler plates
Continuity plates	1/2" plates with c.p. weld
Boundary conditions	Single-sided test, no floor slab, axial load in bottom half of column equal to beam shear, specimen tested in flat position
Other detailing	At bottom flange, remove B.U. bar, add 3/8" reinforcing fillet

N.A. = not available

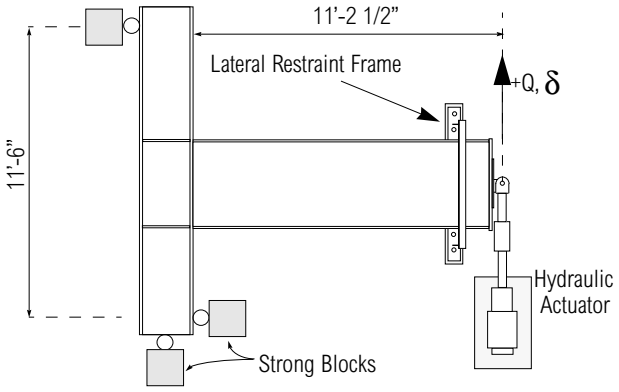
*Coupon locations per ASTM

BACKGROUND

This was the test of repairs to specimen UCB-PN3 originally tested on February 28, 1995. The original specimen failed suddenly during the second positive excursion to $3\delta_y$, when the beam bottom flange groove weld fractured along the entire flange width. The fracture plane coincided with the surface of the column flange; there was virtually no penetration of the crack into the column. The crack may have initiated in the zone at the root of the weld. After the weld fractured, the shear tab bent and tore along the bolt line, shearing three bolts. Prior to failure, it was observed that the yield zone in the beam flanges extended approximately 10 in. from the column face. In addition, the shear tab yielded at its top and bottom corners. The standard SAC/ATC-24 loading history was used in the testing, and the testing was performed quasi-statically. The reference loading displacement (δ_y) for the specimen was specified as 1.00 in.

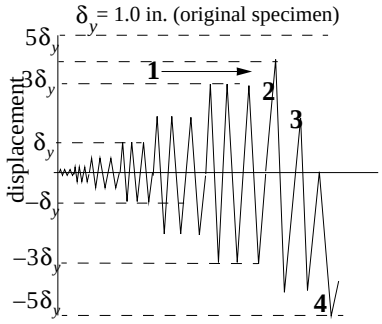
The original specimen had fractured beam top and bottom flanges, and its repair procedure consisted of completely removing the entire fracture region and an extra 2 in. of sound metal in the top flange, completely removing the groove weld at the bottom flange, providing new complete penetration welds at the top and bottom flanges, removing the back-up bar and adding a 3/8 in. reinforcing fillet at the bottom flange, removing the remaining shear tab bolts and the shear tab plate, and welding a new shear tab on the opposite side of the beam web.

TEST SET-UP



DISPLACEMENT HISTORY AND KEY EXPERIMENTAL OBSERVATIONS

Applied Displacement History



Key Observations of the Test

Point	Description
1	Yielding in the beam web and the beam flanges
2	Yielding observed in the panel zone
3	Initiation of a fracture at the edge of the beam bottom flange, propagating through the flange, with a short branch near the flange axis
4	Fracture of the top beam flange across its entire width

DETAILED TEST RESULTS

Quantity (see Introduction for definitions used in UCB tests)		Maxima
Force/Displacement Properties	Peak actuator force (kips):	225
	Beam deformation (in.) total/beam only:	3.6/2.08
	Experimental yield displacement (in.)	1.00
Rotation Capacity	Maximum plastic rotation (% radian) total/beam only:	1.61/0.96
	Cumulative plastic rotation (% radian):	N.A.
Energy Dissipation Properties	Cumulative energy dissipated (k-in.):	5040

Mode of failure: Fracture of the beam bottom flange weld during the second positive displacement excursion to $4\delta_y$.

DISCUSSION

Specimen UCB-RN3 displayed visual indications of yielding during the first excursion to $2\delta_y$. The yielding occurred in the beam flanges and in the beam web near the weld access holes. After the completion of the first displacement excursion to $4\delta_y$, considerable nonlinearity in both beam flanges, in the beam web, and in the panel zone was noted. The specimen failed during the next displacement cycle to $4\delta_y$, at a displacement of 1.48 in. A fracture initiated at the edge of the beam bottom flange and propagated across the entire flange with a short branch near the flange axis. Loading was continued, and the positive and negative excursions were completed. During the first negative excursion to $5\delta_y$, the beam top flange fractured across its entire width. Prior to failure, the maximum plastic rotation of the connection was approximately 1.69% radian.