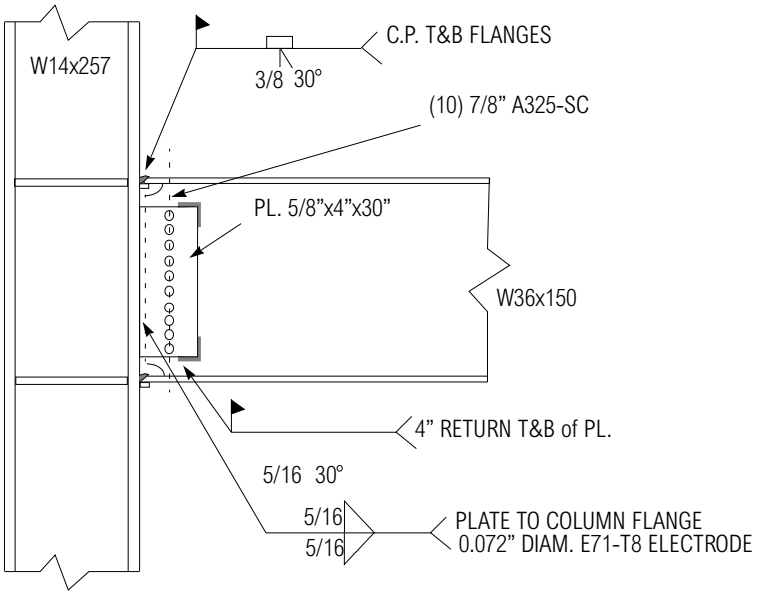
SAC Steel Project

Test Summary No. 12

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

Specimen ID:	UCB-PN3
Keywords:	Pre-Northridge, simulated field welding, bottom flange fracture, bolt yielding, top flange tear, small rotation capacity
Test Location:	University of California, Berkeley
Test Date:	February 27-28, 1995
Principal Investigator:	Egor P. Popov; with Marcial Blondet, Lev Stepanov, and B. Stojadnovic
Related Summaries:	26
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 NA web	72.5	67.8 flange 76.1 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	5/8"x30"x4" plate with ten 7/8" A325 bolts
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 lower half of column equal to shear in beam, specimen tested in flat position
Other detailing	5/16" fillet weld upper and lower ends of shear tab

N.A. = not available

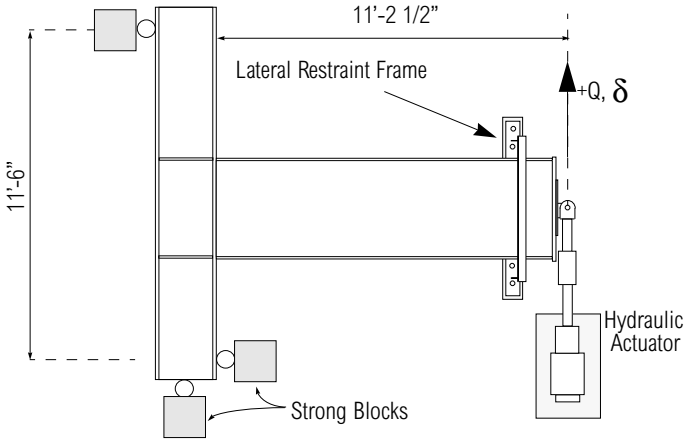
*Coupon locations per ASTM

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. This was the only specimen of the pre-Northridge designs tested at the UCB labs with a beam of the specified A36 material. The other two specimens, UCB-PN1 and UCB-PN2 (described in Test Summaries No. 10 and 11), were inadvertently fabricated with A572 Grade 50 beam steel. Specimen UCB-PN3 was of similar size and material to the specimen described in Test Summaries No. 7, 8, and 9 that were tested at the University of Texas at Austin. 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.

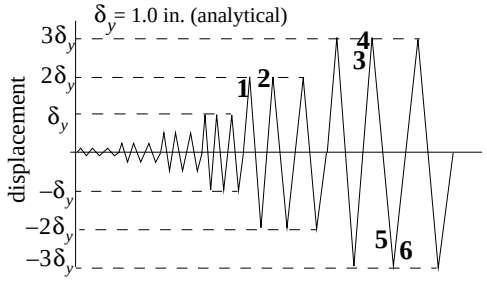
The standard SAC/ATC-24 loading history was used in the testing, and the testing was performed quasi-statically. The reference loading displacement (δ_y) for the specimen was specified as 1.00 in.

TEST SET-UP



DISPLACEMENT HISTORY AND KEY EXPERIMENTAL OBSERVATIONS

Applied Displacement History



Key Observations of the Test

Point	Description
1	Yielding in the panel zone and beam flanges
2	Yielding and bolt movement in the shear tab
3	Complete fracture through the beam bottom flange weld
4	Tearing of the shear tab, and fracture of bolts
5	Tearing of the beam top flange weld
6	Load resistance capacity reduced to 65% of peak

DETAILED TEST RESULTS

Quantity (see Introduction for definitions used in UCB tests)		Maxima
Force/Displacement Properties	Peak actuator force (kips):	198
	Beam deformation (in.) total/beam only:	2.67/1.74
	Experimental yield displacement (in.)	0.94
Rotation Capacity	Maximum plastic rotation (% radian) total/beam only:	1.07/0.81
	Cumulative plastic rotation (% radian):	NA
Energy Dissipation Properties	Cumulative energy dissipated (k-in.):	2400

Mode of failure: Fracture of the beam bottom flange weld during the second positive excursion to $3\delta_y$ cycle.

DISCUSSION

Specimen UCB-PN3 exhibited yielding in both the panel zone and the beam flanges during the first displacement cycle to $2\delta_y$. During the $2\delta_y$ cycles, 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 the top and bottom corners, and slight movement in the shear tab plate due to bolt slip was noted. The specimen failed suddenly during the second positive excursion to $3\delta_y$. The beam bottom flange groove weld fractured along the entire flange width. The crack 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 at the root of the weld. After the weld fracture, the shear tab bent and tore along the bolt line, shearing the bottom three bolts. Yielding of the beam flanges extended approximately 18" from the face of the column. The test was continued until two $3\delta_y$ cycles were completed. During the negative excursion, the groove weld of the top flange of the beam began to tear starting at the edge of the flange and extending 9 in. During the negative excursions, the specimen capacity was 65% of its maximum prior to the failure. The failure at the top flange weld also induced a crack at the top of the shear tab. Prior to failure, the maximum plastic rotation of joint was approximately 1.07% radian.