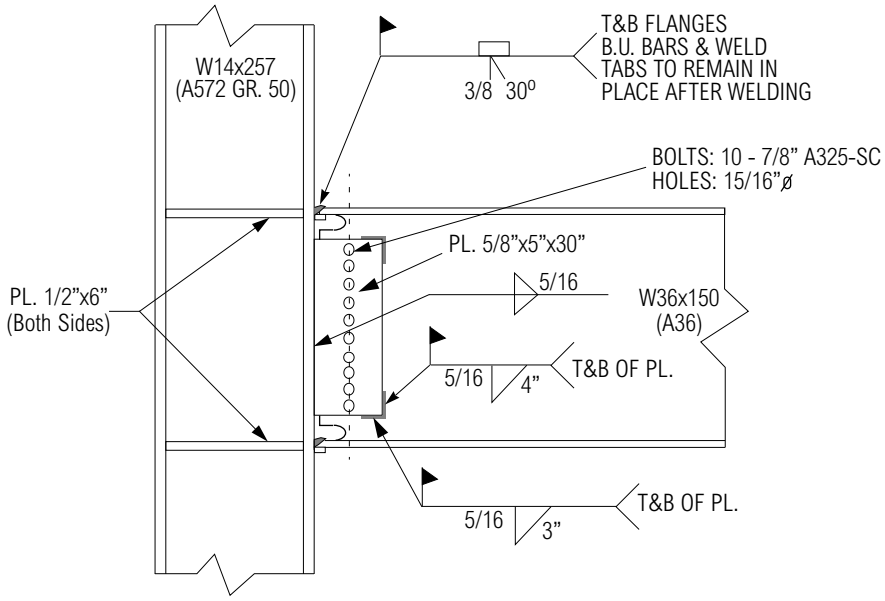
SAC Steel Project

Test Summary No. 8

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

Specimen ID:	UTA-2
Keywords:	Pre-Northridge, simulated field welding, column flange fracture, shear tab bolt failure, small rotation capacity
Test Location:	University of Texas, Austin
Test Date:	March 24, 1995
Principal Investigator:	Michael D. Englehardt; with Bradley D. Shuey and Thomas A. Sabol
Related Summaries:	22
Reference:	"Experimental Investigations of Beam-Column Subassemblages", *Report No. SAC 96-01*, March 1996.
Funding Source:	FEMA / SAC Joint Venture, Phase 1

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	58.5	42.3 flange 47.7 web	67.5	61.1 flange 63.4 web
Column	W14x257	A572 Gr. 50	53.5	48.7 flange	72.5	69.0 flange

Welding Procedure Specification	Fillet Weld: FCAW-SS; 0.072" diameter AWS E71T-8 electrode; conforms with AWS 5.20 specification and Section 4.2 of AWS D1.1-94 CJP groove weld: FCAW-SS; 0.120" diameter AWS E70T-4 electrode; conforms with AWS 5.20 specification and Section 4.2 of AWS D1.1-94
Shear tab	5/8"x30"x5" 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 force in lower half of column equal to beam shear force, specimen tested in upright position
Other detailing	Leave backup bars and weld tabs in place, root defects determined from UT inspection left in place

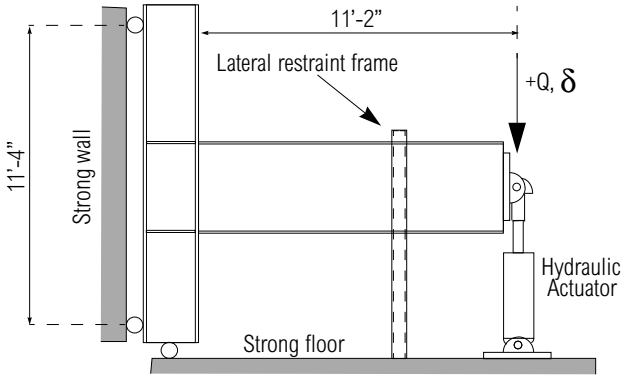
* dynamic stresses; see reference for additional details of coupon tests

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. 7 and 9. In addition, these were intended to be nearly identical to the specimens described in Test Summaries No. 10, 11, and 12 which were tested at U.C. Berkeley. 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.

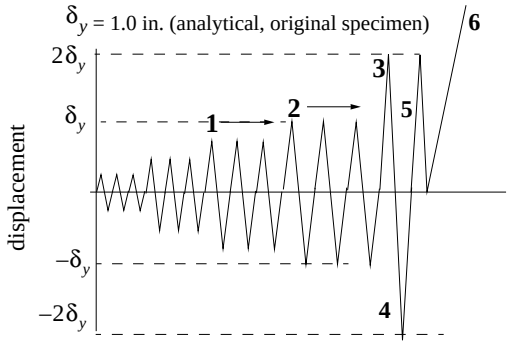
The standard SAC/ATC-24 loading history was used in the testing, and the testing was performed quasi-statically. The yield displacement (δ_y) of the specimen was determined to be 1.00 in., from analysis. The specimen was tested until material fracture occurred, after which the specimen was unloaded and then reloaded in order to determine its post-fracture behavior.

TEST SET-UP



DISPLACEMENT HISTORY AND KEY EXPERIMENTAL OBSERVATIONS

Applied Displacement History



Key Observations of the Test

Point	Description
1	Yielding of beam flanges
2	Beam flange yielding is more pronounced; gap appeared between bottom flange backing bar and column flange
3	Panel zone yielding, presence of a small (0.5 in.) crack at the lower supplementary web weld
4	Small cracking of upper supplementary web weld, bolt slip and yielding in shear tab, cracking of top flange groove weld above the web
5	Fracture of beam bottom flange connection in the form of divot fractures on both sides of the web
6	Failure of three shear tab bolts

DETAILED TEST RESULTS

Quantity (see Introduction for definitions used in UTA tests)		Maxima
Force/Displacement Properties	Peak actuator force (kips):	~175
	Beam tip displacement (in.):	2.0
	Experimental yield displacement (in.)	NA
Rotation Capacity	Maximum plastic rotation (% radian):	0.6
	Cumulative plastic rotation (% radian):	NA
Energy Dissipation Properties	Cumulative energy dissipated (k-in.):	NA

Mode of failure: "Divot" fracture of column flange adjacent to the beam bottom flange connection during the second positive displacement excursion to $2\delta_y$.

DISCUSSION

Specimen UTA-2 failed in the first half of the second displacement cycle to $2\delta_y$. Prior to failure, the beam flanges yielded in the $0.75\delta_y$ and $1.0\delta_y$ cycles. During the δ_y cycles, the panel zone also yielded, and a small gap appeared between the beam bottom flange backing bar and the column flange. During the first cycle to $2\delta_y$, small cracks were discovered at the upper and lower supplementary vertical web welds, and some bolt slip in the shear tab was noted. In addition, a crack was noted directly over the beam web in the beam top flange groove weld. A sudden fracture occured at the beam bottom flange connection during the next cycle. Through-thickness delaminations (or "divot" fractures) appeared in the column flange on both sides of the beam web. The fracture extended from the weld root into the column flange and resurfaced on the column flange face approximately 0.5 in. above the beam bottom flange. The fracture to the right of the web formed a crescent shape that extended from the weld root and terminated inside of the column flange. After this failure was observed, the specimen was loaded to a displacement of 2.75 in. During this extended cycle three of the shear tab bolts failed. The specimen experienced plastic deformations and rotations. The maximum plastic rotation of the connection was approximately 0.6% radian. The beam contribution was approximately 2/3 of this value.