SAC Steel Project

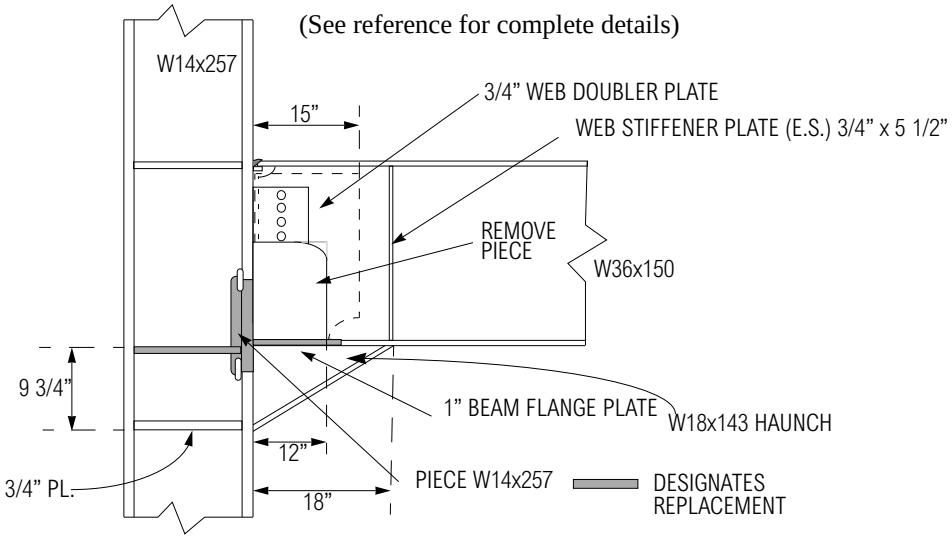
Test Summary No. 25

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

Specimen ID:	UCB-RN2
Keywords:	Repaired, doubler plate, beam flange plate, column replacement piece, haunch beam, panel zone, and column yielding, beam crack, medium rotation capacity
Test Location:	University of California, Berkeley
Test Date:	August 15, 1995
Principal Investigator:	Egor P. Popov; with Marcial Blondet, Lev Stepanov, and B. Stojadnovic
Related Summaries:	11
Reference:	"Experimental Investigations of Beam-Column Subassemblages", *Report No. SAC 96-01,* March 1996.
Funding Source:	FEMA / SAC Joint Venture, Phase I

CONNECTION DETAIL

(See reference for complete details)



MATERIAL PROPERTIES AND SPECIMEN DETAILS

Member	Size	Grade	Yield Stress (ksi)		Ultimate Strength (ksi)	
			mill certs.	coupon tests *	mill certs.	coupon tests *
Beam	W36x150	A572 Gr. 50	62.6	60.6 flange 60.1 web	74.7	68.8 flange 69.7 web
Column	W14x257	A572 Gr. 50	53.5	48.3 flange NA web	72.5	67.8 flange 76.1 web
Beam flange plate	1" plate	A36	N.A.	N.A.	N.A.	N.A.
Column splice	W14x257	A572 Gr. 50	N.A.	N.A.	N.A.	N.A.
Web doubler plate	3/4" plate	A36	N.A.	N.A.	N.A.	N.A.
Haunch	W18x143	Gr. 50	N.A.	N.A.	N.A.	N.A.
Vertical stiffeners	3/4" plate	A36	N.A.	N.A.	N.A.	N.A.

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	5/8"x30"x4" plate, weld to beam web, remove bolts; web doubler plate added
Panel zone	No doubler plate
Continuity plates	Original 1/2" plates with c.p. weld at top, replace lower, add 3/4" at haunch level with c.p. weld
Boundary conditions	Single-sided test, no floor slab, axial load in lower half of column equal to beam shear, specimen tested in flat position
Other detailing	Haunch installed/removed/replaced, therefore bottom beam flange and column flange underwent welding and gouging procedure twice

N.A. = not available

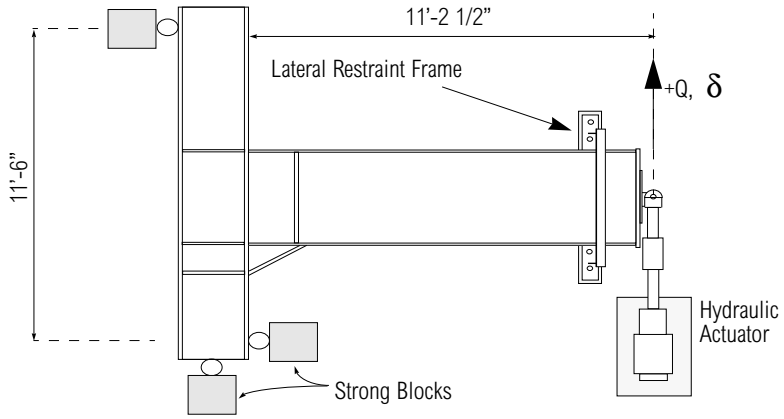
*Coupon locations per ASTM

BACKGROUND

This was a test of repairs to specimen UCB-PN2 wihch was originally tested on February 16, 1995. The original specimen failed suddenly during the second positive excursion to $2\delta_y$. Prior to failure, yielding was observed in the panel zone. The failure mode involved fracture of the column flange across its entire width. The crack started in the bottom flange weld, then extended diagonally across the column flange and entered the panel zone. In the panel zone the crack extended upwards along the column flange. The length of the crack was approximately 10 in. The yield displacement (δ_y) for the specimen was specified as 1.00 in.

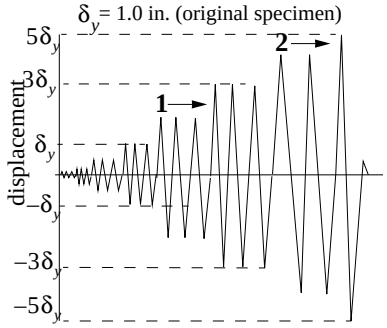
The repairs consisted of removing the bottom continuity plate, a section of the beam flange, and a section of the column web and flange; replacing the removed column section with a new W14x257 Gr. 50 piece; adding a new A36 beam flange plate to connect the beam bottom flange to the newly placed column piece; welding the existing shear tab to the beam web and removing the bolts; welding a new beam-web doubler plate to the column flange and the beam web on the opposite side of the shear tab; adding a new bottom continuity plate, a new Gr. 50 tapered haunch, and a new A36 vertical web stiffener. The standard SAC/ATC-24 loading history was used in the re-test, and the testing was performed quasi-statically.

TEST SET-UP



DISPLACEMENT HISTORY AND KEY EXPERIMENTAL OBSERVATIONS

Applied Displacement History



Key Observations of the Test

Point	Description
1	Yielding observed in the beam bottom flange near the haunch, the beam top flange, lower portion of the panel zone, and at the back of the column near the top continuity plate
2	Fracture of the beam bottom flange at the connection between the haunch and the vertical web stiffener

DETAILED TEST RESULTS

Quantity (see Introduction for definitions used in UCB tests)		Maxima
Force/Displacement Properties	Peak actuator force (kips):	319
	Beam deformation (in.) total/beam only:	4.02/2.31
	Experimental yield displacement (in.)	0.87
Rotation Capacity	Maximum plastic rotation (% radian) total/beam only:	1.77/1.11
	Cumulative plastic rotation (% radian):	N.A.
Energy Dissipation Properties	Cumulative energy dissipated (k-in.):	7440

Mode of failure: Fracture of the beam bottom flange at the connection between the haunch and the web stiffener during the first $5\delta_y$ cycle.

DISCUSSION

Specimen UCB-RN2 sustained all displacement cycles up to and including the $4\delta_y$ cycles with increasingly noticeable signs of yielding in the beam bottom flange near the haunch, in the beam top flange, in the lower panel zone, and on the back of the column flange opposite the top continuity plate. The specimen failed during the first $5\delta_y$ excursion, at a displacement of 4.02 in. A fracture initiated at the edge of the beam bottom flange at the intersection between the haunch and the vertical web stiffener, propagating along the haunch into the beam web. In the beam web, the crack branched in two with the first branch extending approximately 4 in. through the beam flange and 1 in. from the haunch edge, and the second branch stretching for approximately 1.5 in. diagonally through the beam web. The maximum plastic rotation of the connection was approximately 1.77% radian.