SAC Steel Project

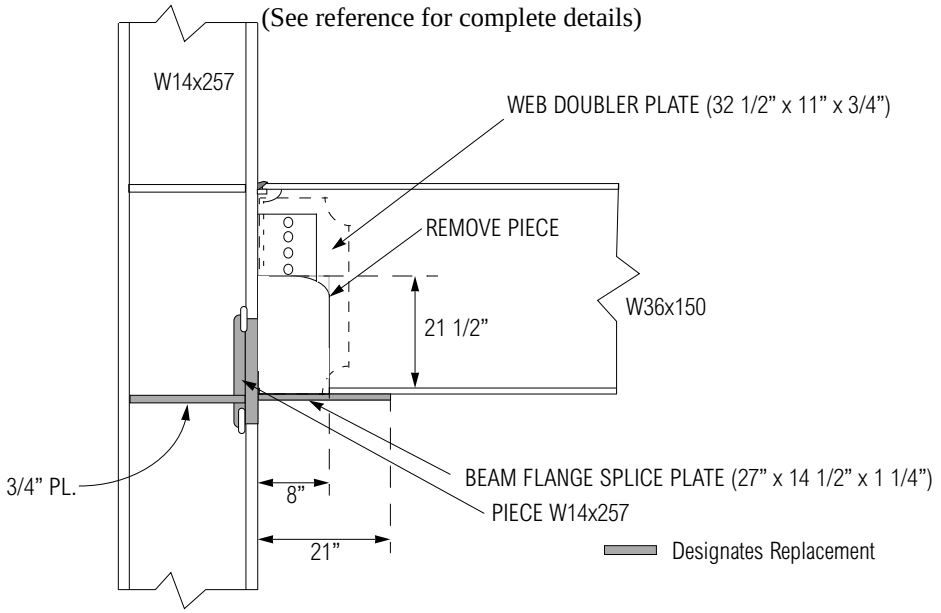
Test Summary No. 24

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

Specimen ID:	UCB-RN1
Keywords:	Repaired, beam doubler plate, beam splice plate, column replacement piece, beam and column flange yielding, weld crack, medium rotation capacity
Test Location:	University of California, Berkeley
Test Date:	August 2, 1995
Principal Investigator:	Egor P. Popov; with Marcial Blondet, Lev Stepanov, and B. Stojadinovic
Related Summaries:	10
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 splice plate	1 1/4" 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	N.A.	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 bottom plate with a 3/4" 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	No repairs to top flange

N.A. = not available

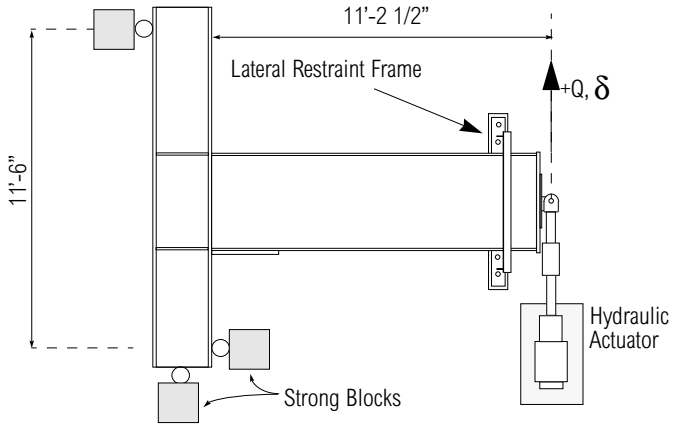
*Coupon locations per ASTM

BACKGROUND

This was a test of repairs to specimen UCB-PN1 which was originally tested on February 9, 1995. The original specimen failed during the second positive excursion to $3\delta_y$. The failure mode was fracture of the column flange adjacent to the bottom beam flange. The failure initiated underneath the backing plate at the beam bottom flange weld. It extended diagonally across the flange and entered the corner of the panel zone. In the panel zone, the crack branched in two directions. Significant yielding in the column flanges and the lower part of the continuity plate was noted. Minor yielding in the panel zone and the beam flanges was observed. The reference loading displacement (δ_y) for the specimen was specified as 1.00 in.

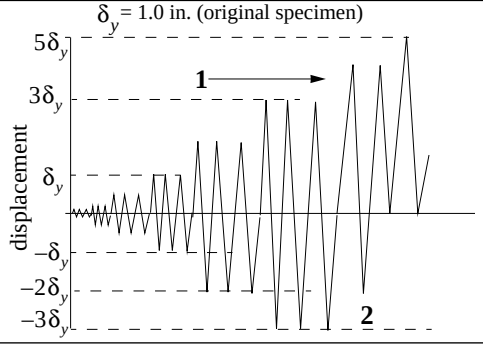
The repair consisted of removing a section of the beam flange and web, removing the bottom continuity plate, removing a section of the column web and flange, replacing the removed column section with a new W14x257 Gr. 50 piece, welding the column flange and web, adding a beam splice plate to connect the beam bottom flange to the newly placed column piece, welding the existing shear tab to the beam web and removing the existing bolts, welding a new beam web doubler plate to the column flange and the beam web on the opposite side of the shear tab. The standard SAC/ATC-24 loading history was used in the testing, and the re-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 of the beam top flange, beam bottom splice plate, and back flange of the column at the bottom web stiffener
2	Fracture of the beam top flange weld, initiating in the middle and propagating towards the edges.

DETAILED TEST RESULTS

Quantity (see Introduction for definitions used in UCB tests)		Maxima
Force/Displacement Properties	Peak actuator force (kips):	260
	Beam deformation (in.) total/beam only:	3.54/1.43
	Experimental yield displacement (in.)	1.08
Rotation Capacity	Maximum plastic rotation (% radian) total/beam only:	1.55/0.49
	Cumulative plastic rotation (% radian):	N.A.
Energy Dissipation Properties	Cumulative energy dissipated (k-in.):	4440

Mode of failure: Fracture of the beam top flange weld during the first negative $4\delta_y$ cycle.

DISCUSSION

Specimen UCB-RN1 behaved elastically up to and including the $1\delta_y$ cycles. The specimen sustained three displacement cycles at $2\delta_y$, and three displacement cycles at $3\delta_y$ with some yielding of the beam top flange, the beam bottom splice plate, and the back flange of the column at the lower continuity plate level. The measured beam flange strains significantly exceeded the yield value. Strain gages also indicated yielding in the panel zone. The specimen failed during the first negative excursion to $4\delta_y$. A fracture initiated at the middle of the beam top flange and propagated to the flange edges. Due to unloading, the crack stopped 1 in. short of the edges of the beam flange. The maximum plastic rotation of the connection was approximately 1.50% radian.