SAC Steel Project

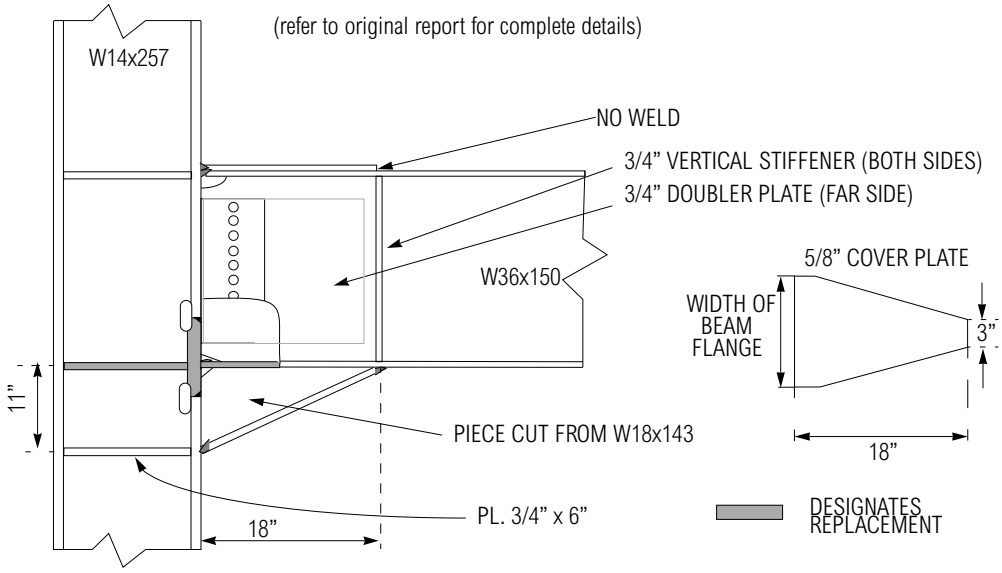
Test Summary No. 21

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

Specimen ID:	UTA-1RB
Keywords:	Bottom haunch, top cover plate, web doubler plate, replacement plates, beam flange and web buckling, column bowing, specimen twisting
Test Location:	University of Texas, Austin
Test Date:	November 10, 1995
Principal Investigator:	Michael D. Englehardt; with Bradley D. Shuey and Thomas A. Sabol
Related Summaries:	7, 20
Reference:	"Experimental Investigations of Beam-Column Subassemblages", *Report No. SAC 96-01*, March 1996.
Funding Source:	FEMA / SAC Joint Venture, Phase I

CONNECTION DETAIL

(refer to original report 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	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
Haunch	W18x143	A572 Gr. 50	N.A.	46.2 flange	N.A.	70.7 flange
Web doubler plate	3/4" plate	A572 Gr. 50	N.A.	N.A.	N.A.	N.A.
Column flange splice	2" plate	A572 Gr. 50	N.A.	N.A.	N.A.	N.A.
Beam flange splice	1" plate	A572 Gr. 50	N.A.	N.A.	N.A.	N.A.
Vertical stiffeners	3/4" plates	A572 Gr. 50	N.A.	N.A.	N.A.	N.A.
Cover plate	5/8" plate	A572 Gr. 50	N.A.	54.3	N.A.	77.1

Welding Procedure Specification	Original: see Test Summary No. 7 Modifications: All welds FCAW-SS using 0.072" diameter AWS E71T-8 electrode.
Shear tab	5/8"x30"x5" plate, added 3/4" beam web doubler plate welded to beam web and column flange
Panel zone	No doubler plates
Continuity plates	1/2" plates with c.p. weld, replace bottom plate, add 3/4" plate at bottom of haunch 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	CJP replacement weld at top flange performed prior to installation of cover plate; no fillet weld at end of cover plate, remove weld tabs

N.A. = not available

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

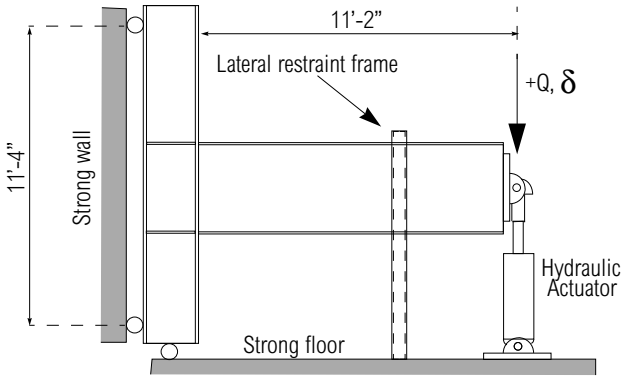
BACKGROUND

This was a retest of repairs to specimen UTA-1 (Test Summary No. 7) which was originally tested on March 30-31, 1995. The repaired specimen (denoted UTA-1R, Test Summary No. 20) was tested on September 26, 1995. The repaired specimen had experienced some slight top flange buckling prior to the fracture of the beam top flange to column flange weld during the second displacement excursion to $4\delta_y$.

The repair schedule consisted of back-gouging and removing the existing beam top flange weld material, grinding the surface smooth, welding the beam top flange to the column flange, back-gouging the root to sound metal and removing the weld tabs, welding the cover plate to the column flange, and fillet welding the cover plate to the beam top flange.

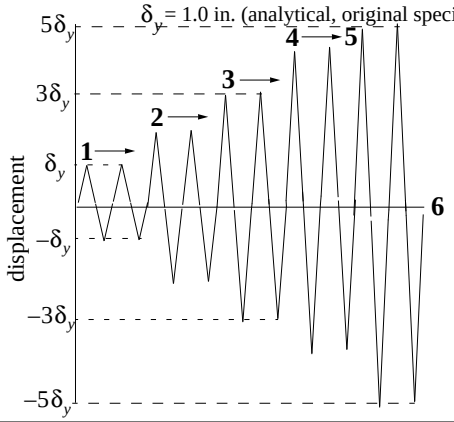
The displacement loading history deviated from the standard SAC/ATC-24 protocol. The three sets of cycles in the elastic range were eliminated, and the number of displacement cycles in the subsequent sequences was reduced to two. These modifications were made because of the flange buckling which remained in the specimen from the previous tests. The yield displacement (δ_y) of the specimen was selected as 1.00 in. to be consistent with that used in the previous tests.

TEST SET-UP



DISPLACEMENT HISTORY AND KEY EXPERIMENTAL OBSERVATIONS

Applied Displacement History



Key Observations of the Test

Point	Description
1	Buckling of beam top flange
2	Increased buckling of beam top flange
3	Beam web buckling, panel zone yielding, and slight column bending
4	Beam top and bottom flange buckling; increased panel zone yielding, column bending; slight twisting in bottom haunch
5	Severe top flange buckling, top continuity plate buckling, column bending and twisting
6	Termination of testing due to severe lateral torsional buckling of the specimen at the face of the haunch

DETAILED TEST RESULTS

Quantity (see Introduction for definitions used in UTA tests)		Maxima
Force/Displacement Properties	Peak actuator force (kips):	~300
	Beam tip displacement (in.):	5.0
	Experimental yield displacement (in.)	NA
Rotation Capacity	Maximum plastic rotation (% radian) face of column/face of haunch:	2.8/3.3
	Cumulative plastic rotation (% radian):	NA
Energy Dissipation Properties	Cumulative energy dissipated (k-in.):	NA

Mode of failure: No material fracture or substantial degradation in strength observed; tests stopped after displacement cycles to $5\delta_y$ due to severe twisting in the specimen.

DISCUSSION

Specimen UTA-1RB initially experienced buckling in the top beam flange during the $1\delta_y$ cycles. The buckling became more pronounced during the $2\delta_y$ and $3\delta_y$ cycles. Panel zone yielding and column bending were also noted in the $3\delta_y$ cycles. In the $4\delta_y$ cycles, slight buckling in the beam bottom flange outside of the the haunch region was observed, as was additional panel zone yielding, column bending, and twisting in the bottom haunch. During the first $5\ \delta_y$ cycle, the buckling in the beam top flange became severe, and buckling was also observed in the top continuity plate. The bending deformations in the column bending increased, and twisting in the column became apparent. Similar behavior was observed during the second $5\delta_y$ cycle, during which the beam was twisting severely due to beam buckling at the face of the haunch. The test was terminated at this point to avoid damage to the loading apparatus. There was no visible sign of material fracture anywhere in the haunch region or the cover plate region. The maximum plastic rotation measured to the face of the column was approximately 2.8% radian. Almost all of this rotation came from deformations in the beam.