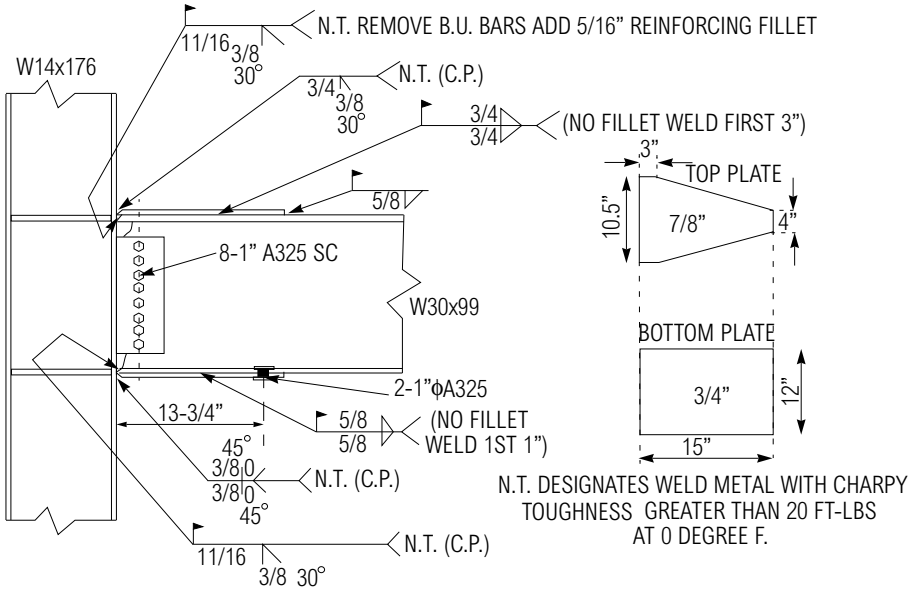
SAC Steel Project

Test Summary No. 27

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

Specimen ID:	EERC-AN1
Keywords:	New connection, top and bottom cover plates, notch tough weld material, local buckling, fillet weld crack, net section fracture, medium rotation capacity
Test Location:	Earthquake Engineering Research Center, University of California at Berkeley
Test Date:	February 2, 1996
Principal Investigator:	Vitelmo V. Bertero; with Andrew S. Whittaker and Amir S. Gilani
Related Summaries:	none
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	W30X99	A36	54.1	50.3 flange 55.7 web	73.4	70.9 flange 71.9 web
Column	W14X176	A572 Gr. 50	56.0	N.A.	75.5	N.A.
Top cover Plate	7/8"	Gr. 50	N.A.	N.A.	N.A.	N.A.
Bottom cover plate	3/4"	Gr. 50	N.A.	N.A.	N.A.	N.A.

Welding Procedure Specification	Groove welds performed with AWS E70TG-K2 electrode. (No further information available)
Shear tab	1/2"× 5" plate with eight 1" A325 bolts
Panel zone	No doubler plates
Continuity plates	3/4" plates with c.p. weld,
Boundary conditions	Single-sided test, no floor slab, axial load in lower half of column equal to beam shear force, specimen tested in upright position
Other detailing	For groove welds back-up bars removed, reinforcing fillet welds added. Cover plate fillet welds to beam flange terminated short of the column flange. Cover plates sized to reduce column through-thickness stress to 40 ksi.

N.A. = not available

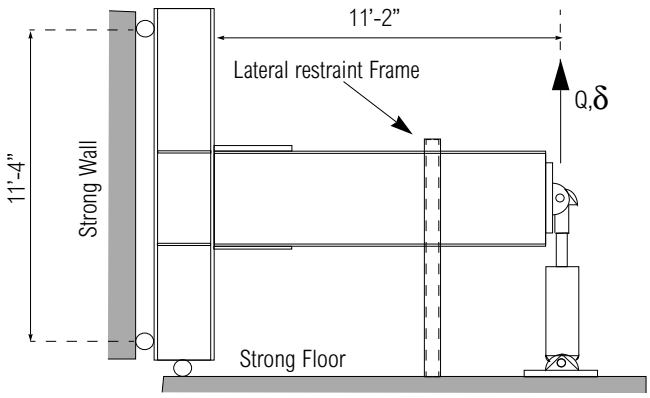
* Coupon locations per ASTM

BACKGROUND

Specimen EERC-AN1 was tested to evaluate the cyclic response of a proposed cover-plated connection for new construction. The beam and column used in this specimen were the same size as those used in the other specimens tested at EERC. The connection was detailed to force plastic deformations to develop in the beam away from the face of the column through the addition of cover plates to the top and bottom flanges of the beam. The design objective was to limit the flexural stresses in the cover-plated joint to 40 ksi at the face of the column.

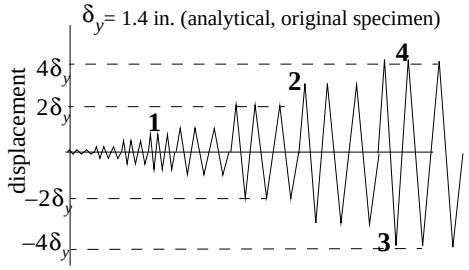
The beam was welded to the column using full-penetration groove welds with a notch-tough electrode (AWS E70TG-K2). The top cover plate was tapered to facilitate down-hand welding to the column and the beam top flange. The bottom cover plate was rectangular and wider than the beam flange to facilitate down-hand welding between the beam flange and the cover plate. The cover plates were groove welded to the column and fillet welded to the beam flanges. Two one-inch diameter A325 bolts were used to clamp the free end of the bottom cover plate to the beam bottom flange, thereby reducing the tendency for the end of the bottom cover plate to pry away from the beam flange. The standard SAC/ATC-24 loading history was used in the quasi-static testing of the specimen. The value of yield displacement (δ_y) was assumed to be 1.40 in. to provide consistency with the other specimens tested at EERC.

TEST SET-UP



DISPLACEMENT HISTORY AND KEY EXPERIMENTAL OBSERVATIONS

Applied Displacement History



Key Observations of the Test

Point	Description
1	Shear yielding in the panel zone
2	Cracking in bottom flange-cover plate fillet weld
3	Local buckling of the beam bottom flange outside the cover plate
4	Net section failure through the bottom flange bolt hole

DETAILED TEST RESULTS

Quantity (see Introduction for definitions used in EERC tests)		Maxima
Force/Displacement Properties	Peak actuator force (kips):	145
	Beam deformation (in.):	3.4
	Experimental beam yield displacement (in.)	0.9
Rotation Capacity	Maximum plastic rotation (% radian):	3.0
	Cumulative plastic rotation (% radian):	NA
Energy Dissipation Properties	Cumulative energy dissipated (k-in.):	2772

Mode of failure: Net section fracture of the beam bottom flange at the location of the connection bolts during the second displacement cycle to $4\delta_y$.

DISCUSSION

Specimen EERC-AN1 exhibited signs of shear yielding in the panel zone during the first displacement cycle to $0.75\delta_y$. As the displacements were increased, local buckling initiated in the beam bottom flange adjacent to the bottom cover plate. The large strains in this region led to tearing of the fillet weld joining the cover plate to the beam flange during the first cycle of displacement to $3\delta_y$. This fillet weld progressively fractured during the subsequent displacement cycles to the point at which it reached the line of the bolt holes clamping the cover plate to the bottom flange. Because the cover plate was unable to carry any of the load beyond this location, the full bottom flange tension force was transferred to the section having the bolt penetrations, leading to a net section fracture across the width of the bottom flange during the second negative displacement excursion to $4\delta_y$. The maximum plastic rotation of the connection prior to failure was approximately 0.030 radian. Although the specimen experienced a brittle fracture mechanism, its behavior was improved compared to the original Pre-Northridge specimens.