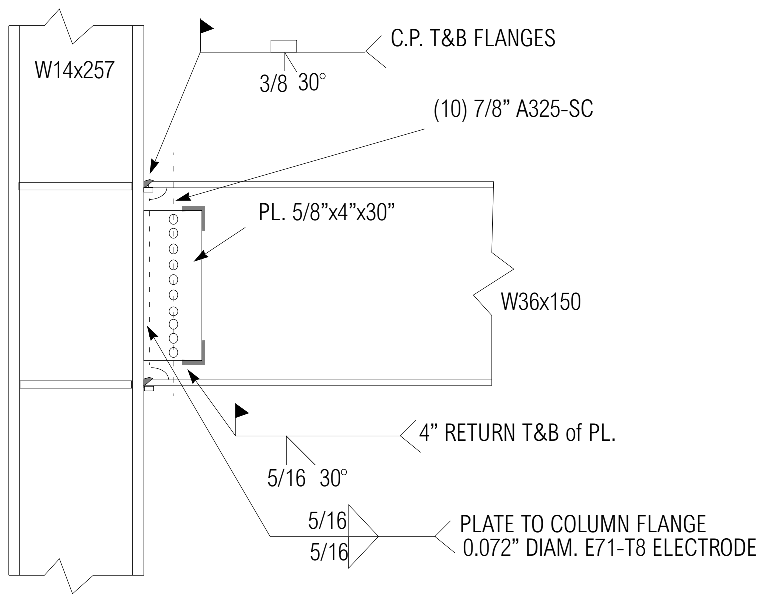
| | |
|---|---|
| Specimen ID: | UCB-PN1 |
| Keywords: | Pre-Northridge, simulated field welding, column flange fracture, continuity plate yielding, small rotation capacity |
| Test Location: | University of California, Berkeley |
| Test Date: | February 9, 1995 |
| Principal Investigator: | Egor P. Popov; with Marcial Blondet, Lev Stepanov, and B. Stojadinovic |
| Related Summaries: | 24 |
| 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 | W36x150 | A572 Gr. 50 | 62.6 | 60.6 flange<br>60.1 web | 74.7 | 68.8 flange<br>69.7 web |
| Column | W14x257 | A572 Gr. 50 | 53.5 | 48.3 flange<br>NA web | 72.5 | 67.8 flange<br>76.1 web |

| | |
|---|---|
| Welding Procedure Specification | All welds FCAW-SS in conformance with AWSD1.1-94, performed with 0.120" diameter AWS E70T-4 electrodes. Preheat and interpass temperature per Table 4.3. Fillet weld of shear tab to beam web performed with 0.072" diameter AWS E71T-8 electrode. |
| Shear tab | 5/8"x30"x4" 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 load in lower half of column equal to shear in beam, specimen tested in flat position |
| Other detailing | 5/16" fillet weld upper and lower ends of shear tab |

N.A. = not available

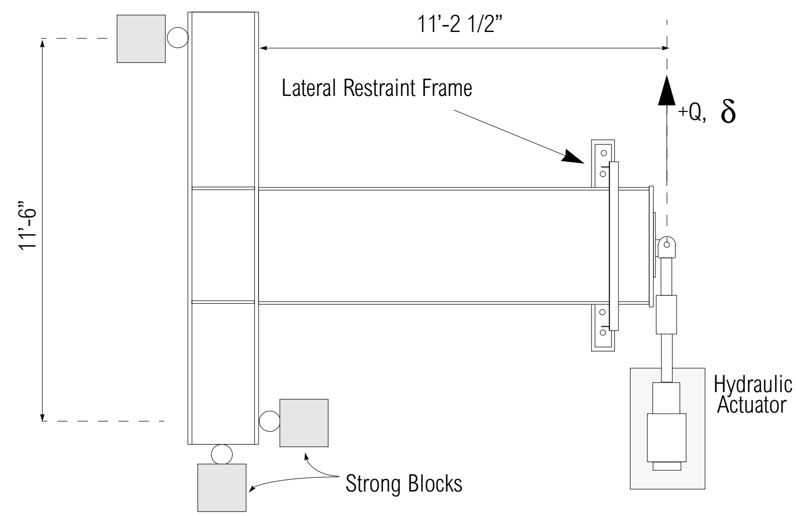
*Coupon locations per ASTM

## 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. 11 and 12. However, Grade 50 beam steel was used in this specimen and Specimen UCB-PN2, instead of the A36 steel which was originally specified. The beam in Specimen UCB-PN3 was fabricated from A36 material. This specimen was also of the same size as the specimens described in Test Summaries No. 7, 8, and 9 that were tested at the University of Texas at Austin. 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.

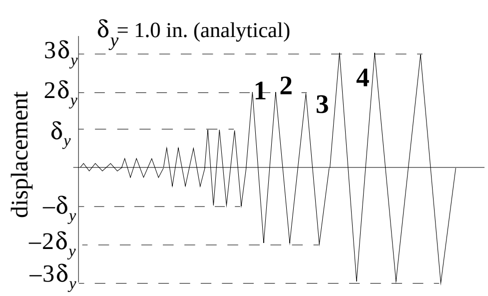
The standard SAC/ATC-24 loading history was used in the testing, and the testing was performed quasi-statically. The reference loading displacement ( $\delta_y$ ) for the specimen was specified as 1.00 in.

## TEST SET-UP




## DISPLACEMENT HISTORY AND KEY EXPERIMENTAL OBSERVATIONS

Applied Displacement History




**Key Observations of the Test**

| Point | Description |
|---|---|
| **1** | Yielding of beam top and bottom flanges |
| **2** | Yielding of the back column flange at the continuity plate level |
| **3** | Yielding in the middle of panel zone, slight bolt movement in the shear tab |
| **4** | Fracture of the column flange adjacent to the beam bottom flange through its entire width |

## DETAILED TEST RESULTS

| Quantity (see Introduction for definitions used in UCB tests) | | Maxima |
|---|---|---|
| Force/Displacement Properties | Peak actuator force (kips): | 223 |
| | Beam deformation (in.) total/beam only: | 2.57/1.22 |
| | Experimental yield displacement (in.) | 0.90 |
| Rotation Capacity | Maximum plastic rotation (% radian) total/beam only: | 0.88/0.33 |
| | Cumulative plastic rotation (% radian): | NA |
| Energy Dissipation Properties | Cumulative energy dissipated (k-in.): | 1680 |

Mode of failure: Fracture of the column flange during the second positive excursion to $3\delta_y$ cycle.

## DISCUSSION

Specimen 10 behaved elastically up to and including the cycles to $1\delta_y$. The specimen yielded during the first excursion to $2\delta_y$. Yielding was noted on both flanges and on the back column flange at the continuity plate level. Slight yielding was also noted in the panel zone. In addition, slight movement in the shear tab plate due to bolt movement was noted. The specimen failed during the second positive excursion to $3\delta_y$. The failure mode was fracture of the column flange through its entire width adjacent to the beam bottom flange. The crack started underneath the backing plate for the beam bottom flange weld. It extended diagonally across the flange to enter the corner of the panel zone. In the panel zone, the crack branched in two directions. One branch extended approximately 8 in. along the continuity plate, and the other branch stretched approximately 10 in. along the column flange. Significant yielding in the column flanges and the lower part of the continuity plate was noted. The maximum plastic rotation of the connection was approximately 0.88% radian, consisting of 0.55% radian from the panel zone, and 0.33% radian from the beam. The failure mode of the specimen with the crack extending throughout the flange width into the column web was observed in several structures after the Northridge earthquake, but this was the first time such a failure had been reproduced in the laboratory. It is likely that the inadvertent overstrength of the beam compared to that assumed in the design (Gr. 50 steel as compared to A36 steel) contributed to this type of failure mechanism.