Published by Elsevier Science Ltd 1996
Paper No.2141. (quote when citing this article)
Eleventh World Conference on Earthquake Engineering
ISBN: 0 08 042822 3

DESIGN OF DUCTILE STEEL BEAM-COLUMN MOMENT CONNECTIONS

K.C. TSAI
National Center for Research on Earthquake Engineering
National Taiwan University, Taipei, Taiwan, ROC

ABSTRACT

The 1994 Northridge earthquake caused unprecedented damage to beam-to-column connections in more than 100 modern steel moment resisting frames (MRFs). Most common were non-ductile fractures near the weldments in the bolted web and welded flanges (BWWF) beam-to-column joint. Exactly one year later, despite the difference in the design and fabrication practice, some similar fractures of steel beam-column connections have also been discovered following the Kobe earthquake. This paper attempts to find possible solutions to the problems by first reviewing some pre-Northridge experimental test results obtained in the US, then the main focus is placed on some parallel work done at the National Taiwan University which in most respects is similar to that done in the US. This relates to the experiments and their interpretation on the conventional and modified BWWF beam-column connections. Results of extensive parametric study indicate that the beam length-to-depth ratio (L/d), the beam flange-to-entire section plastic modulus ratio (ZR), Z_F/Z, and the material yield ratio (YR), F_Y/F_U, are the key factors affecting the ductility performance of conventional BWWF moment connections. Experimental evidence has suggested that a strength criterion, $Z_F F_U \geq \alpha Z F_Y$, may be appropriate for the seismic resistant design of BWWF beam-column connections. Possible enhancement of the BWWF connections with special details is then described in detail. These enhancements are (1) increasing the strength capacity, Z_F, at the beam-column juncture and (2) decreasing the strength demand, Z, in the proximity of the connection. The strength capacity of the connection specimens is enhanced by the use of cover plates or wing plates while the potential strength demand is effectively reduced by drilling holes on the beam flange near the connection. These enhanced connection details reduce the stress near the beam flange weldments, and show experimentally that if a cyclic hardening factor, α, greater than 1.35 is adopted for the design of the modified connections, cyclic plastic rotational capacities greater than 0.025 radian can be achieved. Finally, the paper illustrates the effectiveness of using two types of energy dissipating devices for steel frame structures in reducing the nonlinear demand, the α factor, imposed on the beam-column joints.

KEYWORDS

Steel beam-column connection, Steel moment resisting frame, Moment connection, Welded connection, Plastic hinge, Rotational demand, Cover plate, Stiffener, Energy dissipation, Passive structural control.