World Academy of Science, Engineering and Technology
International Journal of Geotechnical and Geological Engineering
Vol:12, No:06, 2018

Finite Element Study of Coke Shape Deep Beam to Column Moment Connection Subjected to Cyclic Loading

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Abstract : Following the aftermath of the 1994 Northridge earthquake, intensive research on beam to column connections is conducted, leading to the current design basis. The current design codes require the use of either a prequalified connection or a connection that passes the requirements of large-scale cyclic qualification test prior to use in intermediate or special moment frames. The second alternative is expensive both in terms of money and time. On the other hand, the maximum beam depth in most of the prequalified connections is limited to 900mm due to the reduced rotation capacity of deeper beams. However, for long span beams the need to use deeper beams may arise. In this study, a beam to column connection detail suitable for deep beams is presented. The connection detail comprises of thicker-tapered beam flange adjacent to the beam to column connection. Within the thicker-tapered flange region, two reduced beam sections are provided with the objective of forming two plastic hinges within the tapered-thicker flange region. In addition, the length, width, and thickness of the tapered-thicker flange region are proportioned in such a way that a third plastic hinge forms at the end of the tapered-thicker flange region. As a result, the total rotation demand is distributed over three plastic zones. Making it suitable for deeper beams that have lower rotation capacity at one plastic hinge. The effectiveness of this connection detail is studied through finite element analysis. For the study, a beam that has a depth of 1200mm is used. Additionally, comparison with welded unreinforced flange-welded web (WUF-W) moment connection and reduced beam section moment connection is made. The results show that the rotation capacity of a WUF-W moment connection is increased from 2.0% to 2.2% by applying the proposed moment connection detail. Furthermore, the maximum moment capacity, energy dissipation capacity and stiffness of the WUF-W moment connection is increased up to 58%, 49%, and 32% respectively. In contrast, applying the reduced beam section detail to the same WUF-W moment connection reduced the rotation capacity from 2.0% to 1.50% plus the maximum moment capacity and stiffness of the connection is reduced by 22% and 6% respectively. The proposed connection develops three plastic hinge regions as intended and it shows improved performance compared to both WUF-W moment connection and reduced beam section moment connection. Moreover, the achieved rotation capacity satisfies the minimum required for use in intermediate moment frames.

Keywords : connections, finite element analysis, seismic design, steel intermediate moment frame
Conference Title : ICEES 2018 : International Conference on Earthquake Engineering and Seismology
Conference Location : San Francisco, United States
Conference Dates : June 06-07, 2018