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Seismic Behavior of Post-Tensioned Steel Connections with Top and Seat Angles

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Abstract

Post-tensioned (PT) connections are used in steel moment resisting frames to eliminate structural damage and minimize residual drifts under seismic loads. A steel post-tensioned connection with top and seat angles has recently been developed. The connection includes top and seat angles bolted to the beam and column. Strands are placed along the length of the beam, passing through the column and posttensioned to provide a pre-compression of the beam against the column. The angles act as energy dissipation devices in PT connections. In this research the seismic responses of steel buildings with semi rigid post-tensioned connections (PT) are estimated and compared with those steel buildings with typical rigid (welded) connections. Different parameters influence on behavior of PT steel connection. The parameters investigated in this study include the angle size, angle gage length, beam flange reinforcing plates, shim plates, number of strands, initial posttensioning force and stiffened angles. The obtained results show that MRF wit PT steel connections represent better behavior in respect with MRF with welded connections. Also it can see that by increasing number of strands, angle size, initial posttensioning force and adding stiffener to angles, PT connection represent better behavior, and increasing gauge length decreases moment resistant of the frame.

Keywords: Post Tension, Steel Connection, Moment Resistance, Energy Absorption

1. INTRODUCTION

Steel moment-resisting frames (MRFs) are designed to provide adequate ductility during earthquake excitements and dissipate seismic energy due to plastic deformations. Welded beam to column connections (pre-Northridge connections) were commonly used for steel moment resisting frames before the Northridge earthquake. The widespread damage to MRFs during the 1994 Northridge earthquake showed that these typical beam–column connections had inherent vulnerabilities at their beam-to-column welds. The complete penetration groove welds at top and bottom beam flanges that were fractured before deformation of plastic hinges in the beams [1]. Brittle fractures in welded connections can occur due to different reasons, such as: welding incorrectly so that lead to porousness in weldments, defective materials and unsuitable electrode. Figure1 shows typical moment welded connections in steel moment-resisting frames (MRFs) consisted of welded beam flanges and a shear tab [2].

Several alternative moment connection details have been proposed since the Northridge earthquake [3]. In an attempt to develop ductile response under earthquake loading, many studies were performed to improve the cyclic behaviour of beam–column connections in MRFs. Examples of such researches were done by Tremblay and Filiatrault [4] on reduced beam section (RBS) connections, Uang et al. [5] on rehabilitated connections with welded haunches, Engel hardt and Sabol [6]on reinforced connections with cover plates and Shiravand and Deylami [7]on restrained connections with side plates. The design approaches were modified by the Federal Emergency Management Agency (FEMA 350–351) [1,8]to provide stable plastic hinges in the beam without weld fractures.