8th International Congress on Civil Engineering,
May 11-13, 2009, Shiraz University, Shiraz, Iran

Moment-rotation behavior of bolted Top-seat angle connections

Akbar Pirmoz [1], Ebrahim Mohammadrezapour [2]
1- Naghsh Afarin Mehraz Consulting Engineers, Tehran, Iran
2- M.Sc., Civil Engineering Dept. K.N.Toosi University, Tehran, Iran

a.pirmoz@gmail.com
rezapour.e.m@gmail.com

Abstract

Bolted top and seat angle connections are mainly designed to sustain gravitational loads of simply supported steel beams. However, the inherent flexural resistance of top-seat angle connections may not be ignored when an accurate analysis of semi-rigid steel frames is desired. The goal of the current study is to find a new moment-rotation relation to estimate the behavior of connections of this type. Semi-analytical equations are proposed for this purpose based on the data bank, which is created using finite element simulation. Several refined 3D finite element models were created based on the previous experimental studies and their accuracy is examined through a comparison to test results from previous studies and other published numerical models. The presented new semi-analytical method covers some deficiencies of the previously proposed methods, and the accuracy of this approach is evaluated comparing its results with those of the other methods. The applicability of the presented method is evaluated, and it is shown that the model estimates the moment-rotation response of this type of connections.

Keywords: bolted angles; moment-rotation relation; nonlinear finite element;

1. INTRODUCTION

Analyzing and designing a semi-rigid frame requires a clear understanding of the moment-rotation relations of its connections. Many studies have been performed world-wide to estimate the moment-rotation behavior of bolted top and seat angle connections. Also the ductility and favorable seismic performance of semi-rigid frames with bolted connections with respect to the corresponding welded frames has been studied [1-4]. The behavior of bolted top and seat angle connections with and without web angles has been investigated and equations have been proposed to model the behavior of these types of connections under cyclic loads [4, 5].

The behavior of bolted angles under cyclic loads has been extensively studied in [6-8]. Recently, the advent of high speed computers has made it possible for numerical modeling methods, like the finite element method (FEM), to be used by researchers to study the connections behavior. Citipitioglu et al [9] used the FEM to study the moment-rotation behavior of bolted top and seat angle connections. In this research, the effect of bolts pre-tension and the friction coefficient on the connection moment-rotation behavior is studied.

Kishi et al [10] studied the applicability of the three-parameter power model of Kishi-Chen [11] to predict the moment-rotation behavior of top-seat bolted angle connections using the FEM. Ahmed et al. [12] performed a parametric study on the prying action of the connection bolts. Pirmoz [13] studied the behavior of bolted angle connections under cyclic loads using a nonlinear FEM. Despite the accuracy of the FEM, this study showed that it is a time consuming method to predict the connection behavior under cyclic loads. Effect of beam dimension on the moment-rotation response of bolted angle connections and the seismic performance of semi-rigid frames with such connections is studied by Danesh and Pirmoz [14]. Danesh et al [15] and Pirmoz et al [16] studied the effect of shear force on the initial rotational stiffness of bolted top and seat angle connections with double web angles and proposed equations to predict the reduction factor of initial connection initial stiffness due to the shear force. Behavior of bolted top-seat angle connections under axial tension and moment loading is studied by Pirmoz [17] and Pirmoz & Mohammadrezapour [18]. Because of the complexity of the 3D nonlinear finite element method required to estimate connection moment-rotation behavior, several analytical equations have been proposed to estimate the behavior of this type of connection. Kukretti & Abolmaali [6] proposed four methods to predict the moment-rotation behavior of bolted top-seat angle connections using a cure fitting technique. Using the experimental test results, Shen & Astaneh-Asl [19] proposed a three-linear moment-rotation behavior based on the fiber element formulation. Based on the strength of the angles relative to the bolt strength, two mechanisms were formed in