Journal of Constructional Steel Research 76 (2012) 13–27

Contents lists available at SciVerse ScienceDirect

Journal of Constructional Steel Research

Experimental and analytical behavior of bolted end-plate connections with or without stiffeners

A. Abidelah [a], A. Bouchaïr [b,c,*], D.E. Kerdal [a]

[a] LM2SC, Civil Engineering Department, U.S.T.O, B.P. 1505 El M'Naouer, Oran, Algeria
[b] Clermont Université, Université Blaise Pascal, Institut Pascal, BP 10448, F-63000 Clermont-Ferrand, France
[c] CNRS, UMR 6602, Institut Pascal, F-63171 Aubière, France

ARTICLE INFO

Article history:
Received 27 December 2011
Accepted 11 April 2012
Available online 18 May 2012

Keywords:
Bolted connection
End-plate with stiffener
Bolt forces
Moment–rotation
Semi-rigid behavior

ABSTRACT

This paper presents the experimental results of eight specimens of steel bolted connections beam-to-column and beam-to-beam with flush or extended endplate. Four of the connections have the end-plates reinforced with stiffeners in the extended parts. The column used is with low resistance to observe the competition between the failure modes in the tension and compression zones. The results are analyzed on the basis of the global moment–rotation curves and the evolution of the tension forces in the bolts. The main parameters observed are the failure modes, the evolution of the resistance, the stiffness and the rotation capacity. The experimental results are used as a basis of comparison with the analytical results given by the component method of Eurocode 3. The main goal of this comparison is to evaluate the accuracy of the analytical method including the connections with stiffeners in the extended part of the end-plates.

1. Introduction

Bolted connections with end-plate are commonly used in structural steel buildings [1,2]. However, their mechanical behavior is relatively complex to analyze due to the discontinuities in the connection zones. Furthermore many parameters have an influence on their behavior such as the bolt positions and their spacing, the end-plate, the column and beam dimensions, the pretension in the bolts, the steel properties of the bolts and plates, the evolution of the contact zones, the positions of the compression center and the presence of stiffeners in the end-plates (Fig. 1). In general, the behavior of these connections is predicted using experimental tests, sophisticated finite element models and analytical approaches [3,4]. The component method proposed by EN1998-1-8 [5] allows the prediction of the behavior of end-plate connections. However, it does not specify explicitly the case of end-plate stiffeners. Nevertheless, many research works carried out on stiffened end-plate connections that are going to be presented hereafter show that the stiffeners somehow modify their behavior in many ways.

Ghobarah et al. [6,7] conducted two series of tests on end-plate connections with unstiffened and stiffened end-plates and concluded that the presence of the stiffeners reduced the deformations of the plate in its extended part. Tsai and Popov [8] pointed out that the use of an end-plate rib stiffener combined with stronger bolts could significantly improve the behavior of extended end-plate connections under large cyclic loading, which could then be designed to develop the full plastic moment capacity of the beam. They also noticed that the prying forces were reduced by the use of the end-plate rib stiffener.

Seradj [9] who carried tests on eight-bolt stiffened extended beam-to-column end-plate connections under cyclic loading came to the conclusion that this type of connection might act as either a fully rigid or a semi-rigid connection depending mainly on the thickness of the end-plate and the bolt diameter, connections with thinner end-plates and thicker bolts behaving more like semi-rigid connections. Adey et al. [10] found that the presence of extension stiffeners increased the connection flexural strength, yield rotation as well as its energy dissipation capacity.

Shi et al. [11,12] tested stiffened and extended steel beam-to-column end-plate connections. They proposed a new theoretical model to evaluate their moment–rotation relationship that fit well with the experimentally obtained ones. They found that the use of extended stiffeners increased the connection flexural strength, yield rotation, rotation capacity and energy dissipation capacity, and that the stiffeners prevented plasticity and deformation to concentrate too much in the zones of welding throats in the extended part of the end-plate.

Shi et al. [13] tested beam-to-column bolted end-plate connections and welded-plate columns and beams under cyclic loading and concluded that both the end-plate stiffener and the column flange stiffener made an essential contribution to the behavior of end-plate connections. These end-plate stiffeners by ensuring the continuity of the beam web alter the mode of failure of the connection, change the distribution of the forces in the bolts, and consequently influence the mode of deformation of the connection components [14].

* Corresponding author at: Clermont Université, Université Blaise Pascal, Institut Pascal, BP 10448, F-63000 Clermont-Ferrand, France. Tel.: +33 473407521.
E-mail address: Abdelhamid.bouchair@univ-bpclermont.fr (A.. Bouchaïr).

0143-974X/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jcsr.2012.04.004