Case Studies in Structural Engineering 1 (2014) 26–31

Contents lists available at ScienceDirect

Case Studies in Structural Engineering

journal homepage: www.elsevier.com/locate/csse

Study of steel moment connection with and without reduced beam section

Swati Ajay Kulkarni [a,*], Gaurang Vesmawala [b,1]

[a] Department of Applied Sciences & General Engineering, Army Institute of Technology, Pune 411015, Maharashtra, India
[b] Department of Applied Mechanics, Sardar Vallabhbhai National Institute of Technology, Surat 395007, Gujarat, India

ARTICLE INFO

Article history:
Available online 9 May 2014

Keywords:
Steel structures
Moment connection
Welded joints
Reduced beam section
Cyclic loads

ABSTRACT

This paper presents test results of two connections tested under cyclic loading. The testing programme addressed connection with reduced beam section (RBS) versus without RBS moment connection. RBS connection is widely investigated and used in US, Japan and Europe. However, design of such type of connection is not presented and used in India. This study is conducted to learn, the advantages and usefulness of RBS connection against connection without RBS for Indian profiles. A theoretical model is also created with the finite element method and the results are compared with those obtained from the experimental study. The analysis observed that specimen without RBS performed poorly due to cracks started at the bottom flange weld. The specimen with RBS reached rotation capacity of 0.02 radians without damage in the welds.
© 2014 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-SA license (http://creativecommons.org/licenses/by-nc-sa/3.0/).

Introduction

The RBS (Fig. 1) connection is one of the most popular and most economical type amongst post Northridge (1994) and Kobe (1995) connections. Number of analytical and experimental studies have been performed on RBS moment connection to examine: flange cut reduction geometry, beam web to column flange connection detail, behaviour of panel zone, requirement of continuity plate, lateral and local instability of beam, effect of composite slab, and usefulness for retrofitting, etc. Further, prequalified RBS connection details and guidelines are described in FEMA (Federal Emergency Management Academy) 350–351,355-D [1–3] and ANSI/AISC (American Institute of Steel Construction) 341-10 [4], ANSI/AISC 358-10 [5], ANSI/AISC 360-10 [6], National Institute of standards and Technology-NEHRP Seismic Design Technical Brief No. 2 [7], EC8, Part 3 [8] AISC Steel design guide series-13 [9], NIST GCR 11-917-13 [10] and PEER/ATC 72-1 [11].

According to, Indian Standard (IS), IS 12778-2004 and IS 12779-1989 [12,13], hot rolled parallel flange I beam sections are classified into 3 types namely as narrow parallel flange beams (NPB), wide parallel flange beams (WPB) and parallel flange bearing pile sections (PBP). Although, Parametric analysis by Goswami et al. [14] has shown that Indian hot rolled I sections having yield stress 250 MPa do not meet compactness requirements specified in Indian standards as well as of those countries with advanced seismic provision for frames used in high seismic zones. However, hot rolled I beam sections having yield stress 250 MPa are most commonly available and used for steel structures in India. As RBS connection is studied and used widely in US, Japan and Europe, however its study is quite limited with respect to Indian profiles and so not found

* Corresponding author. Fax: +91 20 27157534.
E-mail addresses: swatiakulkarni@gmail.com (A.K. Swati), grv22@yahoo.com (V. Gaurang).
[1] Fax: +91 261 2258709.

http://dx.doi.org/10.1016/j.csse.2014.04.001
2214-3998/© 2014 The Authors. Published by Elsevier Ltd.
This is an open access article under the CC BY-NC-SA license (http://creativecommons.org/licenses/by-nc-sa/3.0/).

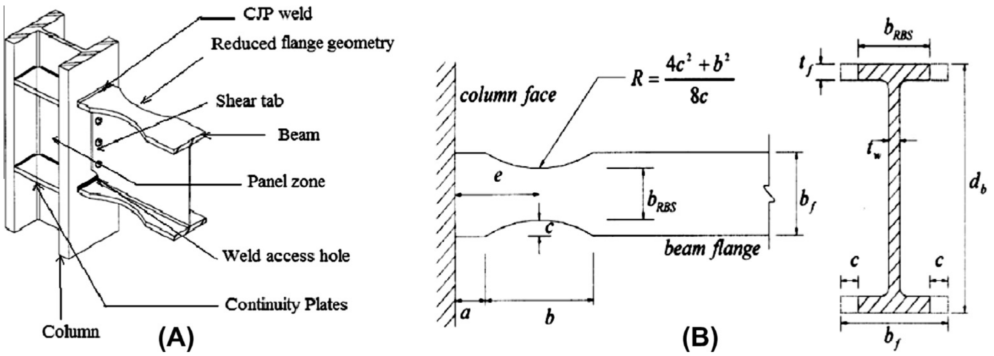

Fig. 1. (A) RBS connection detail. (B) Typical geometry details of RBS.

mentioned in any Indian Standards for steel design IS800-2007, IS808-1989, IS1852-1985, IS 2062-1999, IS8500-1991, IS12778-2004 & IS12779-1989, [15–19,12,13] It can be adopted in India for better performance in strong and intermediate earthquakes [20].Considering the advantages of RBS moment connections and lack of knowledge of the performance of this connection with respect to Indian profiles led to a study on this topic. The objective of this study was to investigate experimentally the cyclic behaviour of welded moment connections with and without RBS. Two external joint specimens were tested to compare and observe connection behaviour. Nonlinear finite element analysis of the connection models performed using the computer programme, ANSYS/Multiphysics.

Design of specimen

Sections with 250 MPa grade were considered for this study. Two specimens were studied, designated as, connection without RBS as 'WRBS' and with RBS as 'RBS'. RBS connection was designed based on specifications given as per AISC and FEMA codes. For panel zone as well as continuity plates, design shear strength, required shear strength & column web/flange thickness limits were studied. The connection was representing an exterior strong-axis connection. Height of the column considered was 975 mm and length of the beam from the centre of the column was 1000 mm. Other, geometrical details are mentioned in Table 1. Table 2 shows the strength of the connection calculated according to AISC/ FEMA formulae. The $M_f/R_yZ_bF_y$ ratio was within the limit (0.85–1) suggested by Engelhardt et al. [21]. Table 3 shows normalized limit states for CP and PZ.

From normalized values (>1) (Table 3) it can be observed that doubler plates as well as continuity plates are not required. Therefore, RBS moment connection without doubler plates and continuity plates was considered for the study.

Experimental study

Specimens were fabricated at Focus Robotomation Ltd. Pune, India and experimental procedure was carried out at Composite Research Centre labs at R&D Engineers, Pune, India. Physical observation of members showed that, geometrical sizes and weights were as recommended by with Indian Standards IS 808-1989 [16] and IS12778-2004 [12]. The sizes/weights of the members considered to model the exterior connection are listed in Table 4. Coupon testing was performed for steel shapes to establish the mechanical properties at Perfect Laboratory Service, Pune, India (see Table 5).

Each beam flange and web was welded at the face of the column using fillet welds. It should be noted that there were no web access holes. The welds' throats were 8 mm for all the specimens. Welds' throat and quality were checked during fabrication. Test setup shown in Fig. 2, consisted of: Supporting frame, Test specimen (external subassemblage, Hydraulic actuator (force rating ±100 kN and stroke length ±125 mm), Data acquisition system and strain gauges YFLA-5 of gauge resistance120 Ω. For the test specimens cyclic loads (Table 6) were applied to the tip of the beam following standard SAC loading history Clark et al. [22].

Table 1
Select members for analysis.

Member (Sr. No. as per IS 12778-2004)		Depth d (mm)	Web Thk t_w (mm)	Flange width b_f (mm)	Flange Thk t_f (mm)	RBS dimensions (mm)			
						a	b	c	R
WPB150(15)	Column	162	8	154	11.5	N.A.			
NPB200(9)	Beam	200	5.6	100	8.5	60	160	25	140.5

Download English Version:

https://daneshyari.com/en/article/250613

Download Persian Version:

https://daneshyari.com/article/250613

Daneshyari.com