Performance of Double I-beams to Box Columns Connections with Reduced Beam Sections

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Abstract

After the 1994 Northridge and 1995 Kobe earthquakes, a wide variety of beam to column connection concepts have been developed for use in steel moment resistant frames and retrofit of existing steel structures. One of these welded moment connections is reduced beam section (RBS) connection. In a RBS moment connection, portions of the beam flanges are selectively trimmed in the region adjacent to the beam to column connection in order to force plastic hinging to occur within the reduced section, and thereby reduce the likelihood of fracture occurring at the beam flange groove welds and surrounding base metal regions. Steel moment resistant frames in Iran mostly are used in medium and high height buildings. The columns of these buildings are often of box types and the beams used in these buildings are either of Double IPE profile types or plate girder. Therefore in this study, RBS connections of Double I-beams to the box columns are studied. The study begins with the Finite Element Analysis (FEA) of a beam-column assembly with a RBS connection, which is compared with test results. The FEA model of RBS connection correlates very well with the actual performance observed during testing. In order to study the nonlinear behavior of these connections, the ANSYS software is utilized and nonlinear of materials and large deformations are considered. Each model was subjected to a cyclic load pattern. In this paper, the impact of effective parameters in the behavior of RBS connections such as depth of the cut, distance from the face of the column to the start of the cut and the length of the cut are studied.

Keywords: Connection, Steel Moment Frames, Reduced Beam Section.

1. INTRODUCTION

Steel moment resistant frames (MRF) are very applicable in the areas that are subjected to earthquake forces because of submitting high ductility as a common structure system. The aim of designing and utilizing these frames is tolerance of large non-elastic deformations due to moment connection of beams to columns, hence it would help forming plastic joint in moment connections during earthquakes. welding connections of beam to column, shown in figure 1, is an especial type of moment connections that was used firstly in America and then in other parts of world. After two earthquakes in Northridge (USA) and Kobe (Japan) with many destruction and losses, it was obtained these connection would not represent ductility properly and disabling to forming plastic joint in beam and yielding in panel zone and failures occurred in connections. Failures occurred in connection was related more to groovy welding of bottom flange of beam to the column and in some cases destruction of some parts of flange or web of column observed. However some other destruction observed such as breaking in shear tab in the weld access holes or rising of welding in the corner of connection of shear tab to column that seems these destructions have occurred after failure in connection of bottom flange beam to column. An example of such failures is shown in figure 2. Poor function of welding moment connections during recent earthquakes raised some questions about reliability of used connections. Various types of moment connections recommended for retrofitting and strengthening the present steel moment frames and constructing new steel buildings. One of these modern welding moment connections that will reduce deficiency in construction processes and have some advantages such as ductility, low cost and so are connections with reduced beam section. At these connections a part of beam flange is cutting, so that momentary capacity of beam in predetermined area is equal to needed. Therefore during the earthquake a large amount of energy resulted from earthquake loads is absorbed due to yield of beam flange and formation