Analytical Study on Side Plate Moment Connections Affecting Cyclic Behavior

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Abstract

The common method of connecting I-beam to box column in the case of moment connections has a main problem, that is brittle fracture of full penetration groove welds of beam flanges to the column. To modify the connection, we have proposed a new detail. In the new geometry of connection, there is a gap between beam end and column face. The moment transfers from beam to the column by two full depth side plates. The tensile force is not directly applied to the column face. Therefore the problems of the brittle fracture of full penetration groove welds are completely eliminated. The finite element method was used for investigating the cyclic behavior of two-way moment connections with side plates. Results show that these connections have high strength and stiffness and cause the ductile behavior of structure with formation of plastic hinges in the beams.

Keywords: Side plate, Plastic hinge, Stiffness classification, Cyclic behavior.

1. Introduction

The behavior of moment connection of I-beam to double-I built-up column was experimentally investigated by Mazrooee et al. (1999). The results of their investigations show that the existence of column cover plate causes the semi-rigid behavior of connection. The problem of large deformation of column cover plate under tensile force of beam flange is very similar to deformation of box columns flange in moment connections without internal diaphragm. Several researchers have proposed innovative solutions to this problem. Blais (1974), from his experimental works concluded that the best way of moment transfer from beam to the box column is using side plates parallel to the column webs. These plates were in levels of beam flanges and connected the sides of beam flanges to the column webs. In his procedure there was a gap between beam end and the face of column. The moments were transferred from the beam ends to column only through the side plates. In a subsequent research Picard and Giroux (1977), continued this innovative concept of connecting I-beam to box column, but they used angles instead of plates. Atsou et al. (1996), proposed nearly similar details. They applied trapezoidal plates in levels of beam flanges to connect beam flanges to the corners of the box column. All of the explained methods were based on the separation between beam ends and face of column. The proposed solutions caused modifications in behavior of moment connections with box columns, but all of them have some defects. After Northridge earthquake, Houghton (2000), proposed a new type of connection to eliminate general problems of welded moment connections. Like the other above mentioned methods, his connection uses the concept of separation between beam ends and the face of column, but he used one full depth side plates in each sides of the beam, instead of two separated plates in each level of beam flanges. The behavior of moment connection of I-beam to double-I built-up column was numerical investigated by Deylami and Yakhchalian (2008). The results of their study show that the existence of column cover plate causes the semi-rigid behavior of connection.

The present paper aims to obtained results of numerical modeling on five subassemblies side plates moment connections. The main objectives are: (1) to make comparison between ordinary rigid connection with side plates moment connection on ductility; (2) to study the effect of full depth of side plate on the concentration stress and equivalent plastic strain at integration point (PEEQ) in different zones; (3) to obtain the influence side plate on dissipated energy by the whole model; (4) to consider panel zone behavior; (5) to consider the combining side plate connection with RBS connection.

2. Numerical Study of RBS Connection

The analytical study involves developing finite element model of connections for the purpose of evaluating the effect of various parameters on connection behavior. Three–dimensional nonlinear finite element of five models were created using ABAQUS computer program. The geometry and boundary conditions of the simple connection were