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NUMERICAL STUDY ON THE SEISMIC BEHAVIOR OF A NEW REDUCED BEAM SECTION CONNECTION BY DRILLED HOLES ON THE BEAM FLANGE

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Since the earthquakes of 1994 in Northridge and of 1995 in Kobe, intensive research and testing efforts have been underway to find better methods to design and construct seismic resistant steel frames. A number of improved beam-to-column connection design strategies have been proposed (FEMA 350), many of which have shown to exhibit satisfactory levels of ductility in numerous tests. Two key concepts have been developed in order to provide highly ductile response and reliable performance: strengthening the connection and weakening the beam framing into the connection, in order to avoid damages of the respective column.

Reduced Beam Section (RBS) moment connection is one of the most economical and practical prequalified connections among the post-Northridge ones (AISC/ANSI 341-16). RBS connections were developed on the basis of a new concept named ''Weakening''. By this concept, the flexural strength of the beam is reduced in the vicinity of the column face, compared to other nearby sections, by beam section reduction, and this forces a plastic hinge to be formed at the reduced location. The localization of the plastic hinge reduces the fracture vulnerability of beam-to-column complete joint penetration (CJP) welds, and therefore the connection inelastic deformation capacity is improved. A conventional type of RBS moment connection was developed by flange shaving and is known as a ''Dog bone'' connection; it was first developed during a research project. The project was sponsored by Arbed (a Luxembourg based steel producer) on the basis of Plumier's idea (Plumier, 1997) in order to provide energy dissipative zones for structures.

A new type of Reduced Beam Section (RBS) connection, "Drilled Flange Connection (DFC)", is presented in this research according to the Figure1-b.

In order to investigate subassemblies were modelled using four noded thin shell elements with reduced integration (element S4R in ABAQUS) under cyclic loading was applied at the end of the beam section.

In this study, the effect of holes arrangement, holes diameter, number of hole rows and distances a, b, c (RBS area) are investigated in order to obtain an appropriate pattern for using in this type of connection and compared with reference connection (RBS). The results were shown that the arrangement of holes with three rows with an unequal diameter from small to large diameters has the best distribution of plastic strain in the beam section away from of column face and have the best bending capacity, as well as without any strength loss up to the 4% total story drift, respectively. Consequently, according to the numerical result illustrated most suitable diameter for drill holes are in the range of $0.1\ b_f \leq D \leq 0.23\ b_f$.

The best distance from the column face (a) is in the range of $0.5\ b_f \leq a \leq 0.75\ b_f$, and the distance of the reduced area (b) is within the range of $b \geq 0.75d$, and the distance between the center of drill holes and edge of the beam flange (c) is within the range of $0.1\ b_f \leq c \leq 0.25 b_f$, which is the best pattern for the particular moment frame.

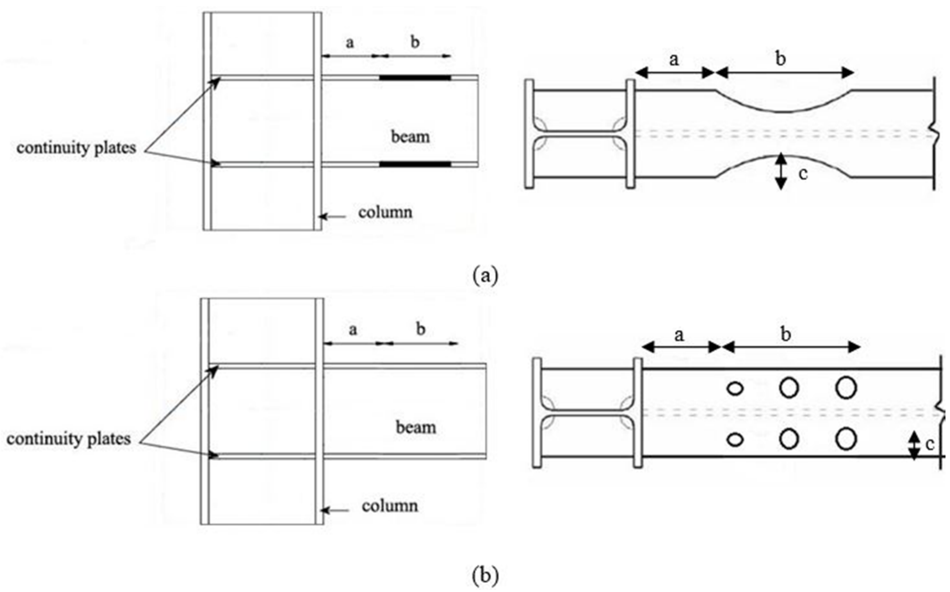

Figure 1. I-beam to H-column connections: (a) RBS, (b) DFC.

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