IMPROVEMENT OF KHORJINI CONNECTIONS

Hassan MOGHADDAM
Professor, Sharif University of Technology, Tehran, Iran
Moghadam@sharif.edu

Shahram HOSSEINZADEH
M.Sc. in Structural Engineering, Sharif University of Technology, Tehran, Iran
Shahram_hosseinzadeh@alum.sharif.edu

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This paper presents a simple method for retrofitting of Khorjini connection and creating a rigid connection with continuous beams. As shown in Figure 1, four plates which are placed between web of beams and edges of column flanges and welded to the column flanges' edges and beam flanges and web, were added to common details in order to improve connection behavior.

Two experimental specimens of the proposed and common details were tested under monotonic loading and used as references for fabrication of the finite element models with software ABAQUS 6.11. Test samples consisted of 2INP160 as column and two sections of INP140 profile as beams. Bottom angles were L100x100x10 profile, with 12 Cm length, while top angles length are 8 and 12 Cm for retrofitted and common connections, respectively. True stress–strain curves for steel and weld materials were used in analysis. Also, cracking in the welds were modeled by Micromechanical method, VGM, which is based on the growth and joining of the voids in ductile metals (Kanvinde and Deierlein, 2004 and Chi et al., 2006).

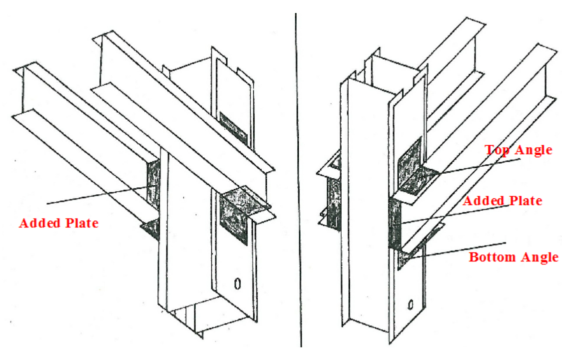

Figure 1. Test sample of the proposed connection

Experimental results show that the proposed connection has a great amount of stiffness and acts elastically up to a considerable amount of the beam ultimate moment. No damage were seen in the connection welds, which proves the added plates advantages in diminishing of high stress and strain concentration in the welds of common Khorjini connection.

Analytical results show that in common Khorjini connection, moment is mainly carried through shear and torsional mechanisms of angles. But in the proposed detail, a significant amount of the moment is directly transferred from beams to column by the added plates and shear mechanism portion reduces mainly. In the case that plates are at the edge of the angles, shear mechanism portion falls below 40 percent of the whole moment of the connection, in most cases. Generally, 30 to 45 percent of the retrofitted connection moment is transferred by angle mechanisms, while 53 to 66 percent are carried by the added plates. The distance of the plates is a vital parameter in the moment distribution and by increasing the distance, shear mechanism falls to about 25 percent and the plates portion goes beyond 70 percent. Although the thickness of the plates is an effective parameter in the moment distribution, but it is not as magnificent as the distance.

Analytical results show that common Khorjini connection never could be considered as rigid. Added plates increase initial stiffness greatly. Initial stiffness of the retrofitted connection is about four to six times the common connection. Also stiffness deterioration in the suggested details is less than the common and the connection maintain its rigidity until beam fails. As beam height increases, more distance is needed for the plates to have a rigid connection. According to the horizontal displacement of the connection angles, equation (1) is proposed for the initial stiffness of the retrofitted connection:

$$K = \Psi \frac{0.208Eh^2\left(\frac{b_{beam}}{b_{top}}\right)^{0.253}}{\left(\left(\frac{b}{L}\right)^{0.661}\cdot\left(\frac{1}{t}\right)^{0.467}\right)_{top}+\left(\left(\frac{b}{L}\right)^{1.101}\cdot\left(\frac{1}{t}\right)^{0.747}\right)_{bot}} \quad (1)$$

Where E, h, b *and* t_L are steel modulus of elasticity, beam height, angle dimension and angle thickness, respectively. b_{beam} and b_{top} are beam and top angle flange dimension and indexes *top* and *bot* stands for top and bottom angles. Also Ψ accounts for plates characteristics and could be calculated from an appropriate relation.

Analytical results show that in the common connection, vertical welds of the angles to column at the face of the beam, is the failure spot of the connection. The connection always fails before beam and cracking moment ranges from 0.35 to 0.9 times the beam plastic moment. But the retrofitted connection never fails, if the plates be placed in the right position. The distance of the plates have a great influence in the cracking behavior of the connections and plates should be placed in a distance more than the length of the bottom angle. Regarding this rule, the beam always fails before the connection.

Stress distribution curves in the critical weld of common connections show that, in the elastic phase stresses are concentrated in a limited length of the weld. But at the moment of rupture due to redistribution of stresses, more regions reach to the weld yield stress and in the 5 mm of the weld ending to the beam flange, stresses goes beyond the weld yield stress and the weld fails at a critical stress of about 1.6 times the weld yield stress. The added plates have a great effect in balancing weld stresses. However as the height of the beam increases, the influence of the plates in reduction of the peek stresses slightly decreases. In the best case, the critical weld peek stress, in elastic phase, decreases to 36 percent of the corresponding connection without plates. Also the weld critical stress, at the failure displacement of the corresponding non-retrofitted connection, never excess 1.2 times the weld yield stress, and in many cases is about the weld yield stress.

Analytical results show that plastic strain distribution in the critical weld of common Khorjini connections is highly non-uniform. At the first 5 mm above the beam flange, plastic strain severely increases and strain jump occurs, causing failure of the weld. The critical weld Plastic strain is compared in retrofitted and common connections, at the failure displacement of the common connections. Results show that, the added plates reduce the peek strain up to 96 percent and in some cases the plastic strain of the critical weld approaches to zero. Although the advantages of the retrofitting decrease slightly with increasing the beam height, but its effects are always remarkable in preventing from strain jump.

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