Ain Shams University
Faculty of Engineering
Structural Engineering Department

Design of bolted connections subject to torsion and shear in the ultimate limit stress state

By
Mohamed Salah Mohamed AbouYoussef

B.Sc. Structural Engineering
Ain Shams University

A Thesis

Submitted in Partial Fulfilment for the Requirements

of the Degree of Master of Science

in Civil Engineering (Structural)

Supervised by

Prof. Dr.
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The American University in Cairo

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STATEMENT

This dissertation is submitted to Ain Shams University to get the degree “Master of Science in Civil Engineering (Structural)”.

The work included in this thesis has been carried out by the author in the Department of Structural Engineering, Ain Shams University.

No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

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ABSTRACT

Usage of steel connections which transfer axial and shear forces in addition to bending moment and/or torsional moment are very important. Thus, analysis of eccentric connections has become the focal point of many researches. Nonetheless, behaviour of eccentric connections subjected to shear forces and torsion in the ultimate limit state is still ambiguous. Most design codes of practice still conservatively use common elastic analysis for design of the mentioned connections even in the ultimate limit states. Yet, there are proposals such as the design method suggested by CAN/CSA-S16 which gives tabulated design aid for the ultimate limit state design of these connections based on an empirical formula. The proposed formula is derived, only for ¾ inch diameter A325 bearing type bolts and A36 steel plates. It was argued that results can also be used with a margin of error for A325 bolts of different sizes and steel of other grades. As such, in this thesis, the performance of bolted connection subject to shear and torsion is experimentally investigated. The behaviour, failure modes and factors affecting both are scrutinized. Twelve connections subjected to shear and torsion with different bolts configurations and diameter are experimentally tested to failure. These connections are divided into four bolted connections with 10mm diameter, four with 12mm diameter and four with 16mm diameter. All bolts are of grade (4.8). Two patterns for bolt distribution are assumed: the first pattern uses 2 bolt rows while the second pattern uses 3 bolt rows. Another test is established to determine ultimate shear force and displacement for bolts diameter 10mm, 12mm and 16 mm. The accuracy of the currently available equation proposed by CAN/CSA S-16 is compared to the outcomes of these tests and design equations for these connections are proposed.

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