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Behavior and Design of Steel I-beam-to-Column Rigid Bolted Connections

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A Thesis
Submitted in Partial Fulfillment for the Requirements
of the Degree of Doctor of Philosophy
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ABSTRACT

Considerable attention has been devoted towards beam-to-column rigid bolted connections. Although different methods of design are introduced in various specifications, yet these methods are not accurate specially in calculating the bolt force and end plate capacity. In this dissertation, a general literature review of the previous studies in the field of rigid connections is presented. An experimental programme has been conducted. Ten full scale specimens for rigid connections were tested with different configurations: five specimens represented flushed end plate connections while the other five represented extended end plate connections. The material properties of the steel plates and bolts were investigated. A nonlinear finite element model which accounts for geometric and material nonlinearities is developed. In this model, 4-node shell elements are used to model steel plates, 8-node solid elements are used to model bolt shank, head and nut while contact elements capable of carrying only compressive forces are used for the contact between the column flange and the head plate. Verification of the proposed finite element model has been performed by comparing its results with the results of the performed experimental study and also with the experimental work previously performed by others. A parametric study is carried out using the verified finite element model for different connection configurations: flushed connections with one and two rows of bolts in the tension side and extended connections with and without stiffeners. Interaction curves for the studied connection configurations have been presented. The influences of bolt diameter, head plate thickness, beam height and bolts edge distances on the connection strength are presented. Furthermore, the effects of various investigated parameters on the bolt force, the prying force and the moment capacity of the connection as well as on the connection's modes of failure have been scrutinized. A comparative study between the finite element results and those using the design equations of the AISC guide No 16 (2002) is performed. Design charts for different connection configurations are also plotted. Equations to calculate the moment capacity of the connections have been proposed using regression analyses. A comparison between the connection moment capacities calculated using the proposed equations and those obtained from the finite element model has been carried out revealing good agreement between them. Conclusions are summarized and recommendations for future researches are listed at the end of the dissertation.

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STATEMENT

This dissertation is submitted to Ain Shams University for the Ph.D. degree in Civil Engineering (Structural Engineering).

The work included in this dissertation has been carried out by the author in the Department of Structural Engineering, Ain Shams University, from May 2005 to March 2010.

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

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