AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Structural Engineering Dept.

Behavior and Design of Bolted Circular Hollow Section (CHS) Moment Connections

A Thesis

Submitted in Partial Fulfilment of the Requirements of the Degree of

Master of Science in Civil Engineering

(Structural Engineering)

By

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Structural Engineer - Dar Al-Handasah

Bachelor of Science in Civil Engineering (Structural Engineering)
Faculty of Engineering, Ain Shams University, 2014

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STATEMENT

This thesis is submitted as a partial fulfilment of the degree of Master of Science in Civil Engineering (Structural Engineering), Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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THESIS SUMMARY

Observing nature, the presence of circular sections is very common, especially in the stems of plants and bones. Circular sections are very efficient, as they can aggregate interesting structural features using less material compared to other type of sections. As an example, circular sections compression resistance is high due to their radial symmetry. Circular hollow sections also do not warp, increasing their torsional resistance. Due to these advantages, combined with an architecturally appealing shape, circular hollow sections are commonly used in many structures. However, despite the qualities, connections treatment in this kind of structures is more complex and requires empirical and numerical tests to check and predict their behaviour.

This research aims to study the behaviour of bolted CHS joints subjected to pure bending moment. Unlike the behaviour of this joint when subjected to axial force, which is extensively studied before, very few research programmes have been performed on its behaviour under the effect of bending moment, leading to an approximate design approach adopted by current codes of practice. The research includes a state-of-the-art literature review for the studied joint covering all aspects related to the joint behaviour and design. The literature review also includes the experimental programme used in the verification of a proposed finite element model for the said connections.

Two finite element models are developed using a general-purpose finite element analysis (FEA) package. Both models are verified against experimental programme found in literature and a good correlation between results is found.

A parametric study is then performed using the finite element models, using the same techniques verified previously in the verification process of the FE model. The studied parameters include endplate thickness (10 mm, 16 mm, 20 mm, or

30 mm) and its configuration (whether stiffened or not), the bolt diameter (M12, M16, M20, M24), the bolt grade (8.8 or 10.9), and their pattern (relative to moment direction; one or two bolts at maximum moment). The parametric study includes the results of 128 model which are divided into eight groups based on the bolt pattern, bolts grade, and the endplate configuration. Each group is comprised of 16 models.

The results of the parametric study are presented in charts and tables and the effects of these parameters on the behaviour are discussed in detail. The capacity of joints obtained by the FEM is then compared to the current design approach and it is found that the current design approach adopted by CIDECT and AISC is over-conservative and does not reflect the actual capacity of these joints.

Alternative design approach is found in the literature, studied, further developed and its results are compared to the results obtained via the finite element analysis. It is found that it yields closer results to the actual capacity of the investigated joints than design approaches adopted by current international design codes.

Keywords: circular hollow sections, CHS, bolted connections, moment connections, CHS splice, numerical modelling, Abaqus, FEA.

TABLE OF CONTENTS